A USERS GUIDE FOR THE REBUS-PC CODE, VERSION 1.4

By

Arne P. Olson

Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439-4815

December 21, 2001

ARGONNE NATIONAL LABORATORY, ARGONNE, ILLINOIS

Argonne National Laboratory, with facilities in the states of Illinois and Idaho, is owned by the United States Government and operated by The University of Chicago under the provisions of a contract with the Department of Energy.

ANL/RERTR/TM-32

A USERS GUIDE FOR THE REBUS-PC CODE, VERSION 1.4

By

Arne P. Olson

RERTR Program
Argonne National Laboratory
Argonne, Illinois 60439-4815 USA

December 21, 2001

ABSTRACT

The Reduced Enrichment Research and Test Reactor (RERTR) Program uses the REBUS-PC computer code to provide reactor physics and core design information such as neutron flux distributions in space, energy, and time, and to track isotopic changes in fuel and neutron absorbers with burnup. REBUS-PC has evolved away from the original REBUS code, which was created starting in the 1960's to study large liquid metal cooled fast breeder reactors. REBUS and REBUS-PC both model the external cycle, and are very general codes with 1D, 2D, and 3D neutronics capabilities, and with complete fuel shuffling capabilities. REBUS-PC has evolved to its present status over the past decade. While it incorporates the same neutronics capabilities from DIF3D 9.0 as does REBUS 9.0 created by the RAE Division of ANL, REBUS-PC has numerous changes and enhancements directed toward the needs of the thermal reactor analyst using WINDOWS or linux-based PC's.

TABLE OF CONTENTS

1. INTRODUCTION

The REBUS-PC code has evolved away from its roots as a design tool for fast reactors to encompass the needs of thermal reactor design and analysis. Since its conception in the 1960's, REBUS (the REactor BUrnup System) has always been a general-purpose tool [1-7]. It was originally designed and coded for the capabilities of large main-frame computers, some of which had "small core memory" and "large core memory." As a result the code was written in modular style, using specialized Argonne Reactor Code (ARC) system routines for file management, memory management, input processing, and so on. The evolution of work stations such as those created by SUN, DEC, and IBM offered cost-effective alternatives to main-frame computing. Over the past ten years, advances in personal computer architecture, hardware, software, and FORTRAN compilers have made using PC's under WINDOWS or linux operating systems the method of choice for many scientific and engineering purposes. The Reduced Enrichment Research and Test Reactor Program (RERTR) has determined that its reactor analysis software, when compiled by the Lahey Fortran 95 [8] (WINDOWS and linux), is very effective even for huge problems when run on present-generation PC's using Pentium IV processors. REBUS-PC is written in FORTRAN 77, as a stand-alone code. Modular features of Lahey Fortran 95 are not used.

The following information is intended to supplement the REBUS 9.0 version which is maintained by the RAE Division of ANL, and which is available from the Radiation Shielding Information Computational Center (RSICC) at Oak Ridge National Laboratory. The user should obtain full documentation for REBUS 9.0 in order to fully utilize the capabilities of REBUS-PC Version 1.4 as described below.

Differences in capabilities between REBUS 9.0 and REBUS-PC are accessed by changes to input datasets A.BURN and A.STP027. The output created by REBUS-PC also has numerous differences from that of REBUS 9.0. Those differences will be described in later sections of this report.

Changes made in REBUS-PC Version 1.4 are as follows:
--Wrapup/Restart is now available, including saving of all *.BCD files. Cases have been restarted successfully in which cross section processing used all three available options: no burnup dependent fits; polynomial fits; and spline fits. The original REBUS wrapup/restart capability for binary files was essentially unchanged, while a new file, RESTRT.BCD, was created in order to save all of the many new text files with names of the form *.BCD.
--File TYPE13.BCD edits are extended. Now dataset A.NIP3 Card Types 13, 14, and 15 are provided at each time node, including active and inactive isotopes. Card Type 35 data for dataset A.BURN is also provided. This information greatly simplifies creation of a REBUS problem to reproduce conditions at a given time node.
--At the birth of the ARC System about 35 years ago, subroutines that processed the input stream were hard-coded to a limit of 99,999 cards in the "INPUT" file. This same limit applied to the maximum number of cards of a given card type number. Recently, a user created a REBUS problem that used a very large card input format cross section library (A.ISO). As the result the job failed. The limit is now extended to 99,999,999 line images. The reason for these limits is that as the INPUT file is processed, it is broken into

separate files, reordered by card type number, and the number of images per card type are counted. This information is written to the first two records of numerous temporary files that only are used internally, such as the AISO and ABURN datasets. In order for certain card types to be found later during the run, files such as AISO may be repeatedly read. The card count information makes this retrieval process precise and efficient. Changes were made to 30 subroutines to extend this limit.

--The ARC System codes were developed to provide for multiple-case capability. No version of REBUS until now has had this capability, although much of the necessary functionality was in place. Since it is extremely convenient to run multiple jobs with only changes being specified, the missing path driver logic was coded, and verified by testing.

--Control over the generation of a huge "STACK" file is now provided as a user option.

2. CHANGES TO A.BURN DATASET

2.1 Revised Type 40 Card

The Type 40 card (Polynomial Least Squares Criteria) has been generalized to admit access to cubic spline fits instead of polynomial least square fits. The polynomial fits were only possible for capture, fission, or both capture and fission cross sections. Cubic spline fits can be made to any of (n,gamma), (n,fission), (n,p), (n,alpha), (n,d), or (n,t) processes. The input parameter #3 or #7 now has the following values:

0	capture (n,gamma) by polynomial fit
1	fission (n,f)) by polynomial fit
2	both (n,gamma) and (n,f)) by polynomial fit
31	(n,gamma) by spline
32	(n,f) by spline
33	(n,p) by spline
34	(n,alpha) by spline
35	(n,d) by spline
36	(n,t) by spline

Note that parameters #4, #5, #8, and #9 have no meaning when spline fits are requested. Also note that the two options are mutually exclusive: one cannot use spline fits for some processes or isotopes, and polynomial fits for others.

The Type 41 card (Burnup Dependent Fitting Data Specifications) has been simplified for user convenience. For complex problems with many isotopes, it is very inconvenient to use this format to supply atom density information at each burn point. The needed information is available on the cross section library file, ISOTXS. This card is needed if one isotope is burned in reference to a different isotope, and the user wishes to use atom density information from the cross section file ISOTXS, rather than supply reference base isotope atom density data on card type 41 fields #4 or #7. Note that if A.BURN is unformatted, the user must insert at least a decimal point in these fields in order to process card type 41 correctly. The presence of "zero" in these fields causes the

POLYFI module to look for card types 46, and to extract the parameter ADENS from the 4D record of data set ISOTXS to be used instead.

2.2 New Type 46 Card

#	Columns	Contents
1	1-2	46
2	7-12	Label of burnable isotope whose burnup depends on the atom density of the label in field 3.
3	13-18	Label of the isotope whose atom density determines cross sections for isotope in field 2.
4	25-30	Same as field 2
5	31-36	Same as field 3
6	43-48	Same as field 2
7	49-54	Same as field 3
8	61-66	Same as field 2
9	67-72	Same as field 3

If A.BURN is formatted, reference base isotope atomic density information on fields #4 or #7 can be supplied as zero or blank if the user wishes to let the POLYFI module find this data from file ISOTXS. Note that if A.BURN is unformatted, then the user must insert at least a decimal point in these fields in order to process card type 41 correctly. The user has complete freedom to mix supplied information with data to be found from ISOTXS. In other words, you can override the ISOTXS information for a given isotope burn point by not naming that isotope on a Type 46 card, and by supplying the burn point information as usual on a Type 41 card. As you will see from the sample output below, the user is informed of the burn point atom density updates taken from ISOTXS.

2.3 SAMPLE INPUT USING A.BURN TYPE 41 and TYPE 46 CARDS

```
41     C1130 C1130         0.      50.      C1131         0.    20.
41     C1130 C1132         0.      10.      C1133         0.    1
41     C1130 C1134         0.       1.      C1135         0.
41     C1130 C1136         0.       1.      C1137         0.
41     C1130 C1138         0.       1.      C1139         0.
41     C1130 C11310        0.       1.      C11311        0.
41     C1130 C11312        0.       1.      C11313        0.
41     C1130 C11314        0.       1.      C11315        0.
41     C1130 C11316        0.       1.      C11317        0.
41     C1130 C11318        0.       1.      C11319        0.
   ----aaaaaabbbbbb------aaaaaabbbbbb------aaaaaabbbbbb------aaaaaabbbbbb
46     C1130 U5CD0        C1131 U5CD1       C1132 U5CD2        C1133 U5CD3
46     C1134 U5CD4        C1135 U5CD5       C1136 U5CD6        C1137 U5CD7
46     C1138 U5CD8        C1139 U5CD9       C11310U5CD10       C11311U5CD11
46     C11312U5CD12       C11313U5CD13      C11314U5CD14       C11315U5CD15
46     C11316U5CD16       C11317U5CD17      C11318U5CD18       C11319U5CD19
```

2.4 SAMPLE OUTPUT ON POLYFI.BCD (when using Types 41 & 46 of A.BURN)

```
<<<<< BEGINNING OF POLYFI >>>>>
JOB ID=                     DATE= 12/01/01
Least-Squares Polynomial Fit Cross Sections
Each fit is sampled at 100 randomly selected points.
Cubic splines may also be used.
POLYFI: LABELS FILE IS ON UNIT=  24 IVER= 1
POLYFI: SCR002 FILE IS ON UNIT=  64
CARD 41 PROCESSING FINDS   20 ISOTOPES FOR WHICH ADENS FROM ISOTXS WILL BE
USED
ISOTOPE SUBSTITUTIONS WILL BE MADE AS FOLLOWS:
C1130   U5CD0     C1131   U5CD1     C1132   U5CD2     C1133   U5CD3
C1134   U5CD4     C1135   U5CD5     C1136   U5CD6     C1137   U5CD7
C1138   U5CD8     C1139   U5CD9     C11310  U5CD10    C11311  U5CD11
C11312  U5CD12    C11313  U5CD13    C11314  U5CD14    C11315  U5CD15
C11316  U5CD16    C11317  U5CD17    C11318  U5CD18    C11319  U5CD19
CARD 41: UPDATING ISOTOPE U5CD0  ATOM DENSITY FROM ISOTXS=  9.9999994D-11
CARD 41: UPDATING ISOTOPE U5CD1  ATOM DENSITY FROM ISOTXS=  9.9178575D-11
CARD 41: UPDATING ISOTOPE U5CD2  ATOM DENSITY FROM ISOTXS=  9.8084180D-11
CARD 41: UPDATING ISOTOPE U5CD3  ATOM DENSITY FROM ISOTXS=  9.6992213D-11
CARD 41: UPDATING ISOTOPE U5CD4  ATOM DENSITY FROM ISOTXS=  9.5902501D-11
CARD 41: UPDATING ISOTOPE U5CD5  ATOM DENSITY FROM ISOTXS=  9.4814587D-11
CARD 41: UPDATING ISOTOPE U5CD6  ATOM DENSITY FROM ISOTXS=  9.3728136D-11
CARD 41: UPDATING ISOTOPE U5CD7  ATOM DENSITY FROM ISOTXS=  9.2642401D-11
CARD 41: UPDATING ISOTOPE U5CD8  ATOM DENSITY FROM ISOTXS=  9.1556727D-11
CARD 41: UPDATING ISOTOPE U5CD9  ATOM DENSITY FROM ISOTXS=  9.0470333D-11
CARD 41: UPDATING ISOTOPE U5CD10 ATOM DENSITY FROM ISOTXS=  8.9382564D-11
CARD 41: UPDATING ISOTOPE U5CD11 ATOM DENSITY FROM ISOTXS=  8.8292477D-11
CARD 41: UPDATING ISOTOPE U5CD12 ATOM DENSITY FROM ISOTXS=  8.7199144D-11
CARD 41: UPDATING ISOTOPE U5CD13 ATOM DENSITY FROM ISOTXS=  8.5550456D-11
CARD 41: UPDATING ISOTOPE U5CD14 ATOM DENSITY FROM ISOTXS=  8.3888382D-11
CARD 41: UPDATING ISOTOPE U5CD15 ATOM DENSITY FROM ISOTXS=  8.2210731D-11
CARD 41: UPDATING ISOTOPE U5CD16 ATOM DENSITY FROM ISOTXS=  7.2110859D-11
CARD 41: UPDATING ISOTOPE U5CD17 ATOM DENSITY FROM ISOTXS=  5.7141888D-11
CARD 41: UPDATING ISOTOPE U5CD18 ATOM DENSITY FROM ISOTXS=  3.5733218D-11
CARD 41: UPDATING ISOTOPE U5CD19 ATOM DENSITY FROM ISOTXS=  2.1263307D-11
DRPOLY PROCESSING REACTION PROCESS= 31 FOR BURNABLE ISOTOPE=X5SF0
```

3. CHANGES TO PATH DRIVER STP027

Logic flow and output edit changes to REBUS-PC are controlled mostly through the Fuel Cycle Standard path BCD Input file, A.STP027. For example, the user can enable edits to the following spread-sheet or text-editor readable files:

ATOMDEN.BCD	Atom densities
CLOAD.BCD	Core load, kg
K-EFF.BCD	table of k-effective at each time node
POLYFI.BCD	output of polynomial or spline fitting to burnup-dependent cross sections
POWER.BCD	DIF3D power printout table by time node
RXSUM.BCD	reaction rate summary
TFLUX.BCD	DIF3D flux printout table by time node

For many years, some of the power-related edits such as burnup have been slightly inconsistent with the power edits from DIF3D. It was determined that the origin of this problem was that DIF3D and the fuel cycle computational module did not use the

same method or data in order to deduce power. DIF3D was correct, while the affected REBUS edits were not fully consistent because updated zone-averaged power conversion factors were not being supplied. This problem was corrected by adding the necessary information to the COMPXS file. In REBUS-PC, the HMG4C module is now called after DIF3D in order to compute the necessary power conversion factors, which are written on file COMPXS.

There are changes in the calculation of the burn matrix when solving the coupled isotopic transmutation equations in module FCC004, compared with REBUS-9.0. Transmutations `between fission products` were not properly accounted for. This only is an issue when the problem has very complex burn chains and many explicit fission products, rather than a simple lumped fission product representation.

Large problems can create huge output files. In order to control this, one can specify that the code should never create a wrapup/restart file, and never create a STACK file. These are new options on Card Type 5.

Output edits of REBUS were originally designed for large mainframe computers with 132 character line printers. All output was sent to text files FT06 and to FT10, and to a series of "summary" text files created by the SUMMARY module. This hardware and software environment greatly influenced the design of the code. But now, in a PC environment, the programmer has much greater flexibility. We have taken advantage of this new flexibility by writing specialized output to a multitude of formatted files for review using standard text editors. The length of output files for complex reactor models has become so large that coding changes were necessary to delete redundant data from them as these files are generated. A backspacing control routine was developed to over-write outdated information on many output files during iterations at the same time point, leaving only the final data. The organization of specialized output has also been significantly improved to ease its use by the reactor analyst.

Conversion from one computer platform to another has required extensive validation of prior benchmark calculations. Due to binary file format differences on different hardware platforms, it was necessary to convert neutron cross section libraries from binary to BCD, and back again. Our standard conversion process codes only retained 6 significant figures–not full single precision. Precise benchmarking cannot be achieved under those conditions. All of the cross section conversion codes, both free-standing and in REBUS-PC, were converted to retain full single precision by retaining 8 significant figures in BCD files. The BCD to binary file conversion process within REBUS-PC was revised to detect and process either format without the need for any change to the input file.

REBUS-PC differs from all other variations in that it now can process multiple cases in "blocks." Each new case begins with a line in the INPUT file that is:
                    BLOCK=STP027
The user can insert datasets, modify them by replacing cards of a given card type number, or remove the cards of a given card type number, or delete the entire dataset. Standard ARC system input card options using BLOCK=, DATASET=, UNFORM=, SUBLOCK=, NOSORT=, and REMOVE=, are all described in Ref. 9. The convention taken by REBUS-PC is that each new block is a new problem. Hence it is not possible to utilize the burned atom densities that exist at the end of block 1 to begin block 2. That

5

can now be readily accomplished by requesting the reactor status information of atom densities, composition definitions, and path definitions on output file TYPE13.BCD. However, subsequent blocks can use the last RTFLUX file as a flux guess (if the spatial mesh is unchanged), and the user only has to introduce changes to his input such as changing control rod positions.

As a caution to the user, it is wise not to use the "no edits for the current BLOCK" option on a line such as:

BLOCK=STP027,3

because then there will be no edits of the modifications which have been made to construct the current block (these edits normally go to output files FT06 and/or FT10). The user will be unable to easily verify that he specified his problem properly.

4. NEW OUTPUT AVAILABLE ON TYPE13.BCD DATASET

The purpose of the TYPE13.BCD dataset, as originally conceived, was to provide isotopic atom densities for all active and inactive isotopes in a REBUS problem, for each time node. This information could then form the basis for constructing an input file for a given time node, to be used for a "snapshot" calculation with a zero burn step length. The user could then obtain any other desired information, such as control rod worths, or temperature effects. The user was still faced with constructing a set of A.NIP3 input cards of Type 14 (Composition Specifications) and Type 15 (Assignment of Region to Composition). The user also had to construct a set of A.BURN Type 35 cards (General Fuel Management Specifications) that matched the A.NIP3 Types 13, 14, and 15 cards. All of this information is now automatically created by REBUS-PC, and written to file TYPE13.BCD.

The user is provided with a complete set of consistent information with which to construct a "snapshot" at any time node: the A.NIP3 cards of Type 13, Type 14, and Type 15; and the A.BURN card Type 35. These card types are marked in columns 74-79 with "A.BURN" or "A.NIP3" to identify where they will be used. In order to construct a "snapshot" input file, it will be assumed that the user has a text editor such as vi and the "grep" utility. The following steps are required:

1. Find the time node in question. Search for "TIME NODEnnn" with a text editor (nnn is a 3 character field with the node number). Within vi, type:
   /TIME NODE
2. Delete all previous lines (Within vi, turn on the line numbers with :set nu command; then you will see which line number the desired information starts on. Go to the top of the file and delete 1 less).
3. Search for the next occurrence of "TIME NODE". Delete it and all subsequent lines (Within vi, move to the first unwanted line and enter a command such as "10000dd" to delete the following 10,000 lines or less).
4. Save the remaining data to a file and name it type13 (within vi enter a command such as :w type13). This file now contains a complete set of information for that particular time node. It begins with the inactive isotopes for all of the materials, and is followed by the active isotopes for all of the materials. Note that nothing is missing. The

general neutronics input processor of REBUS-PC will collect all of the Type 13 cards together, then the Type 14 cards together, then the Type 15 cards together. The fact that they are separated here has no effect on the result of a subsequent REBUS calculation. Exactly the same information is presented now on the Type 13 cards as in the preceding version of REBUS-PC.

5. Separate the information needed by the A.BURN dataset as follows:
grep –i "burn" type13 >aburn
This command separates out all lines that have the text string "burn" on them, and saves them to new file aburn.

6. Separate the information needed by the A.NIP3 dataset as follows:
grep –iv "burn" type13 >anip
This command separates out all lines that do not have the text string "burn" on them, and saves them to new file anip. Steps 5 and 6 have created files aburn and anip, which are just the cards needed to modify the existing A.BURN and A.NIP3 datasets.

7. Now delete any Type 13, 14, or 15 cards from the original input file. Also delete any A.BURN Type 11 and Type 35 cards. Insert the new cards from files anip and aburn. Change the A.BURN Type 3 card time information to define the time at which the problem begins, and provide a zero burn cycle time.

NOTES

1. The output cards are in fixed-format. If the user wishes to use them in a free-format problem (for example his input will use "UNFORM=A.NIP3"), no changes are needed. ARC system input files are only read through column 72.

2. On the TYPE13.BCD dataset are cards that have on them the following text: "redundant if there are inactives present".
This message is placed beyond column 72 so as not to be read. Also, note that these cards are indented 2 spaces, and therefore are comment cards. The normal REBUS problem has both inactives (non-burnable isotopes) and actives in any and all burnable zones. In the unusual event that the problem has a burnable zone with no inactive isotopes in it, then the user must edit these cards by deleting columns 1-2, thereby activating them, and place them with the other A.NIP3 cards. The reason for this complexity is that one part of REBUS edits the inactives, and provides the necessary Types 13, 14 and 15 cards; and another part does the actives as needed on Type 13 cards only.

3. Titles and time node marker cards are indented 2 columns, so they can be left in the file as comment cards.

4. Because the fuel cycle computational module of REBUS-PC may perform fuel shuffling, it only knows what is present in each part of the reactor at any time. Consequently it is necessary to construct unique primary composition labels for use on A.NIP3 Type 15 cards, which refer back to the A.NIP3 Type 14 cards. Since the region labels in the problem are unique, I chose to make up the unique primary composition names by reversing the region label. For example, if the region label was "I9BE6", the composition label became "6EB9I" on card Types 13, 14, and 15. The code also constructs labels for secondary compositions as follows: the name of the first is "S00001", and the number is incremented as needed. These secondary

composition labels appear on card Type 14. Also, the primary and secondary composition labels appear on the A.BURN Type 35 cards. If the code only created the A.NIP3 Type 13 cards, the user would have to create a whole new set of primary and secondary composition labels in order to run a "snapshot" calculation. That is because REBUS expands the input that the user supplies to uniquely apply to each burnable zone.

5. VALIDATION

REBUS-PC has been subjected to an ongoing process of validation, where new changes are introduced and verified against expected benchmark results from older versions of the code, or against REBUS 8.0 or REBUS 9.0. Also, it has been routinely operated on WINDOWS and linux platforms with no changes to the source code. Four sample problems are available for user testing and verification. A linux script is used to automate the comparison of old and new results, and to isolate any differences.

5.1 Validation of the Cubic Spline Fit of Burnup-Dependent Neutron Cross Sections

The reactor analyst needs information in useful form for understanding the physical variables and their effects on his reactor model. Now that essentially all computations are performed on PC's, the RERTR project has initiated an effort to standardize on a few graphics packages for off-line analysis. The `Mathematica` software was used to program (outside of REBUS) the cubic spline algorithms and the polynomial fit algorithms for the purposes of comparison, and to assist in debugging of new FORTRAN-77 coding in REBUS-PC. Experience is being gained as to the relative advantages and disadvantages of polynomial fits versus spline fits. There is essentially no difference in running time, since the computational time involved in processing burnup-dependence is only a few tenths of a percent of the total job time.

Table 5.1 provides a comparison of eigenvalues obtained by polynomial fits versus a preliminary implementation of spline fits, for the BMRR. For this reactor, the effects of burnup-dependent cross sections are not large. Either interpolation method yields practically the same results. The reactivity differences shown are a measure of the reactivity uncertainty introduced by the cross section fitting technique. One advantage of the spline fit process is that the fits actually go through the data points smoothly. This is of particular value for fresh, unburned reactivity calculations.

8

Table 5.1 BMRR Eigenvalue for Each Neutronic Calculation, Using Burnup-Dependent Cross Sections

Time, days	k_{eff} (polynomial)	k_{eff} (spline)	Reactivity difference, 10^{-3}
0	1.053209	1.053503	-0.265
0.33	1.039278	1.039424	-0.135
1.	1.026924	1.026942	-0.017
1.33	1.035560	1.035615	-0.051
2.	1.023934	1.023955	-0.020
2.33	1.034912	1.034973	-0.057
3.	1.023365	1.023391	-0.025
3.33	1.034537	1.034605	-0.064
4.	1.022979	1.023009	-0.029
4.33	1.034165	1.034240	-0.070
7.	1.049590	1.049673	-0.075
7.33	1.037271	1.037349	-0.072

5.2 Verification of "Snapshot" data on file TYPE13.BCD

The standard BMRR test case using spline fits yields an end-of-cycle $k_{effective}$ of 1.037349 at 7.33333 days. Using the output from the new TYPE13.BCD file, a "snapshot" was performed using REBUS-PC that yielded a $k_{effective}$ of 1.037352. The reactivity difference is less than 3. x 10^{-6}, which is within the expected convergence tolerance of DIF3D that was requested (1. x 10^{-5}) in each DIF3D problem. This process, of creating a snapshot input file, is extremely easy and quick to perform.

6. COMPILING, LINKING, AND RUNNING REBUS-PC

ANL uses the LAHEY/Fujitsu Fortran 95 Version 5.60g to compile and link the code. ANL also uses the linux version: Lahey/Fujitsu Fortran 95, Version 6.0c. The recommended library structure for linux is:
/rebv14
        -linpack
        -lapack

One needs first to create a directory called rebv14. Then place the REBUS source code in this directory. Then make two subdirectories: linpack, and lapack. Copy the appropriate source code to those directories. The original source code for VARIANT 9.0 is very

slightly changed in order to be used with REBUS-PC. The remainder of REBUS-PC is heavily modified compared to REBUS 9.0. The changes affecting VARIANT 9.0 are:

> -CALL TIMER changed to CALL TIMEX in 16 subroutines
> -CALL ERROR changed to CALL ERROR1
> -for edits of TFLUX.BCD file, changes were inserted into nhpked.f, sstou1.f, sstou2.f.
> -ginvbc.f error on line 17: IDSP changed to ISDP
> -drdriv.f changed from PROGRAM to SUBROUTINE
> -radf3d.f line 61, DIMENSION IREC2(45) changed to 47.

> Compilation is accomplished as follows:
> > a. go to the /rebv14 directory. Enter: lf95 -c -O --tpp --trap *.f
> > b. go to the /rebv14/linpack subdirectory. Enter: lf95 -c -O --tpp --trap *.f
> > c. go to the /rebv14/lapack subdirectory. Enter: lf95 -c -O --tpp --trap *.f
> Linking is accomplished as follows:
> > go to the /rebv14 directory. Enter: lf95 -o reb6v14 --staticlink *.o linpack/.o lapack/*.o

> Running the code is accomplished as follows:
> > a. Create a "run" directory. Enter: mkdir run
> > b. Go to the run directory. Enter: cd run
> > c. Copy the executable to this directory. Enter: cp /rebv14/reb6v14
> > d. Create an INPUT file, and an ISOTXS or A.ISO file (or any other necessary file). Place a copy of these files in the "run" directory.
> > e. Enter: reb6v14

After the code execution is complete, examine the "run" directory and delete file that are not necessary, such as files with names like "NDS*" and "SCR*". The standard output can be viewed on file FT06, while FT10 is the auxiliary print file. FT10 often contains additional useful information from the run. All of the files whose names end in ".BCD" are viewable using any text editor.

6.1 Use of Script to Run REBUS at ANL
> When the user at ANL runs REBUS through the standard script, it is important to realize that one can save the various *.BCD files such as TYPE13.BCD, just as one saves RTFLUX. One simply provides the full names of the files to be saved, at the appropriate command prompt. Files not named will not be saved.

6.2 Use of WRAPUP/RESTART
> A typical restart job (that did not save the STACK file) will look like:
> > BLOCK=OLD
> > DATASET=ISOTXS
> > DATASET=RESTRT
> > DATASET=RFILES
> > BLOCK=STP027
> >
> > …
> A typical restart job (that did save the STACK and STKDIR files) will look like:

```
            BLOCK=OLD
            DATASET=ISOTXS
            DATASET=RESTRT
            DATASET=RFILES
            DATASET=STACK
            DATASET=STKDIR
            BLOCK=STP027
```

The user is cautioned to save at minimum the files RFILES and RESTRT if restart is anticipated. If a STACK file was requested and saved, it can be passed to the restart job and continue to be extended.

6.3 How to Debug a Problem

A typical problem that is ill-defined will terminate prior to performing a neutronics calculation because there is extensive input checking. The user should not only check at the end of the FT06 file for a record of fatal errors, but he should scan FT06 for keywords such as "ERROR," "FATAL," and "*****". The historical REBUS error messages were numbered by subroutine and generally did not provide much additional information on FT06. An effort has been made to provide text messages that explain the reason for failure, on the output at the point of failure. REBUS generally notes the error and continues processing until a check for the existence of a fatal error is made. If one is found, the job terminates. If only a numbered message such as "ERROR NUMBER 10010 IN SUBROUTINE X" is provided, it will be necessary to examine the source code of subroutine X for that message. Comment cards will probably explain the reason for a fatal error.

The user should not use the "no edits for the current block" option; instead, be sure to use

<p style="text-align:center">BLOCK=STP027</p>

This will ensure that a record will be provided of each dataset as it was constructed from processing that block.

The user should check the output for the name of the major module in which the job terminated. For example, pages created by different modules are titled: DIF3D (3D finite difference and nodal neutronics processor), GNIP4C (general neutronics input processor), HMG4C (cross section homogenization processor), FCI002 (fuel cycle input processor), FCC004 (fuel cycle computational module), POLYFI (burnup-dependent neutron cross section fitting module), etc.

If the job involves burnup-dependent neutron cross sections, check the output from the POLYFI module on file POLYFI.BCD for errors.

As a last resort, turn on the "debug" flag of the module in which the error occurs, and rerun the problem.

Well-defined problems may still fail if the container allocations are inadequate. Note which module was being processed at the time of such a failure, and increase the container allocation for that module.

6.4 Guidance on Using DIF3D

DIF3D provides information on container allocation and needs for various internal data storage options, at the start of a problem. The user should generally expect that most of the time to complete a REBUS-PC calculation will be spent in DIF3D. Also, the largest memory requirements will probably be in DIF3D. In general, the "wall clock time" will be reduced if a problem can be contained in RAM. However, if the PC being used is being pushed to its limits such that extensive paging is required, then the user should consider dropping down to a smaller container size and let DIF3D perform some file input/output rather than cause paging. At ANL, we have found that jobs which require over 90% of the RAM available will run successfully, but they may be very slow to complete. The best advice is to test your system, with your own typical problems, in order to find its limits.

7. CONCLUSIONS

The needs of the research reactor analyst continue to evolve as reactor designs become more complex. Software for reactor analysis must evolve to meet those needs, as well as to take advantage of enormous advances in operating environments and compilers, and computer power afforded by modern PC's and clusters of PC's. REBUS-PC continues to evolve to meet those challenges. Some aspects of the fuel cycle calculations within REBUS-PC, and of the neutronics solution within DIF3D, could be broken into parallel calculations and sent to a cluster of computers. We look forward to the future possibility that some use of the PVM multiprocessing capability as used in MCNP will find its way into other parts of REBUS-PC.

8. REFERENCES

1. J. Hoover, G. K. Leaf, D. A. Meneley, and P. M. Walker, "The Fuel Cycle Analysis System, REBUS," Nucl. Sci. Eng. 45, p. 53, 1971.

2. A. P. Olson, J. P. Regis, D. A. Meneley, and L. J. Hoover, "A User's Manual for the Reactor Burnup System, REBUS," FRA-TM-41, Argonne National Laboratory, September 28, 1972.

3. A. P. Olson, "A User's Manual for the Reactor Burnup System, REBUS-2," FRA-TM-62, Argonne National Laboratory, March 1, 1974.

4. R. P. Hosteny, "The ARC System Fuel Cycle Analysis Capability, REBUS-2," ANL-7721, Argonne National Laboratory, October 1978.

5. B. J. Toppel, "A User's Guide for the REBUS-3 Fuel Cycle Analysis Capability," ANL-83-2, Argonne National Laboratory, 1983.

6. K. L. Derstine, "DIF3D, A Code to Solve One-, Two-, and Three-Dimensional Finite-Difference Diffusion Theory Problems," ANL-83-64, Argonne National Laboratory, 1983.

7. G. Palmiotti, E. E. Lewis, and C. B. Carrico, "VARIANT: VARIational Anistropic Nodal Transport for Multidimensional Cartesian and Hexagonal Geometry Calculation," ANL-95/40, Argonne National Laboratory, October 1995.

8. Lahey/Fujitsu Fortran 95 Language Reference, Revision F, Lahey Computer Systems, Inc. Incline Village, NV, 2000 (Linux Pro 6.0).

9. C. H. Adams et al., "The Utility Subroutine Package used by the Applied Physics Division Export Codes," ANL-83-3, Argonne National Laboratory, April 1983.

APPENDIX I. ABSTRACT

1. NAME AND TITLE

REBUS-PC: Code System for Analysis of Research Reactor Fuel Cycles.

AUXILIARY CODE:

DIF3D 9.0 Solves Finite Difference Diffusion Theory Problems.

2. CONTRIBUTOR

RERTR Program, Technology Development Division, Argonne National Laboratory, Argonne, Illinois.

3. CODING LANGUAGE AND COMPUTER

Lahey Fortran 95 for PC under either WINDOWS or LINUX operating systems.

4. NATURE OF PROBLEM SOLVED

REBUS-PC is a system of codes designed for the analysis of research reactor fuel cycles. It is based on an updated 9.0 version of DIF3D that is similar to RSIC Code Package CCC-653, REBUS-3/VARIANT 8.0 (which is intended for use on unix workstations). The full capabilities of the workstation version are retained and enhanced for use in a PC environment. Two basic types of analysis problems are solved: 1) the infinite-time, or equilibrium, conditions of a reactor operating under a fixed fuel management scheme, or 2) the explicit cycle-by-cycle, or nonequilibrium operation of a reactor under a specified periodic or non-periodic fuel management program. For the equilibrium type problems, the code uses specified external fuel supplies to load the reactor. Optionally, reprocessing may be included in the specification of the external fuel cycle and discharged fuel may be recycled back into the reactor. For non-equilibrium cases, the initial composition of the reactor core may be explicitly specified or the core may be loaded from external feeds and discharged fuel may be recycled back into the reactor as in equilibrium problems.

Four types of search procedures may be carried out in order to satisfy user-supplied constraints: 1) adjustment of the reactor burn cycle time to achieve a specified discharge burnup, 2) adjustment of the fresh fuel enrichment to achieve a specified multiplication constant at a specified point during the burn cycle, 3) adjustment of the control poison density to maintain a specified value of the multiplication constant throughout the reactor burn cycle, and 4) adjustment of the reactor burn cycle time to achieve a specified value of the multiplication constant at the end of the burn step.

REBUS-PC will handle both equilibrium and non-equilibrium problems using a number of different core geometries including triangular and hexagonal mesh. The neutronics

solution may be obtained using finite difference or nodal diffusion-theory methods. Other features include: fully automatic restart capability, no restrictions on number of neutron energy groups, and general external cycle with no restrictions on number of external feeds, reprocessing plants, etc. Fuel management is completely general for nonequilibrium problems.

Microscopic cross sections are permitted to vary as a function of the atom density of various reference isotopes in the problem as appropriate for thermal reactor systems. The previous capability where neutron capture and fission processes were fitted to low-order polynomials as functions of burnup is retained. In addition, the user now may select cubic spline interpolation for (n,gamma), (n,fission), (n,alpha), (n,p), (n,d), and (n,t) reactions as functions of burnup. The user may specify control rod positions at each time node in the problem. Output edits have been extensively revised and better organized for use in a PC environment. A number of ASCII format datasets containing various types of summary results are available for use in tailoring reports with the aid of auxiliary PC software such as spreadsheet or word processor programs.

This is a standalone and expanded version of the modular REBUS-3 code system described in Refs. 1-7. It utilizes the 9.0 update of CCC-649/DIF3D code to obtain the neutronics solution. All but the main program "path driver" of DIF3D 9.0/VARIANT 9.0 (with finite difference and hexagonal nodal option) is included in the code package. Dataset A.ISO is extended to retain full single-precision accuracy for neutron cross sections in BCD format. REBUS-PC operation is fully compatible with the DOE Committee on Computer Code Coordination coding standards and interface data sets [Ref. 10].

Changes were made to power-related edits in REBUS-PC such that they are now consistent with those from DIF3D.

5. METHOD OF SOLUTION

The total reactor burn cycle time is divided into one or more subintervals, the number of which is specified by the user. An explicit burnup is performed in each region of the reactor over each of these subintervals using the average reaction rates over the subinterval. These average reaction rates are based on fluxes obtained from an explicit 1-, 2-, or 3-dimensional diffusion theory neutronics solution computed at both the beginning and end of the subinterval. The transmutation equations are solved by the matrix-exponential technique. The isotopes to be considered in the burnup equations, as well as their transmutation reactions, are specified by the user.

6. RESTRICTIONS OR LIMITATIONS

Very large problems can be solved. LF95 v6.0c is limited to 4 Gigabytes of available memory, 250 files open concurrently, and a maximum file size of 2 Gigabytes.

7. TYPICAL RUNNING TIME

Minutes to many hours depending on size and complexity of problem, and on CPU speed and memory utilized.

8. COMPUTER HARDWARE REQUIREMENTS

The PC version of the code is in production use at Argonne National Laboratory on PC's using Pentium IV and Pentium III processors under the Red Hat Linux 7.2 operating system, using up to 1 Gigabyte of random access memory (RAM). The code can be compiled for use on any PC from Intel 80386, 80486, Pentium, Pentium MMX, Pentium Pro, Pentium II, Pentium III, Pentium IV, and Celeron processors or their generic counterparts.

At least 128 Mbytes of RAM are recommended for program and file buffer storage, and internal data (more RAM is better, as wall clock time is generally reduced when more of the problem is contained in core memory). External data storage must be available for approximately 40 scratch and interface files. Fourteen of these files are random access scratch files (grouped into 6 file groups), and the remainder are sequential access files with formatted or unformatted record types. The code is of modular design, with dynamic memory allocation using two containers whose sizes are dictated by the needs of a given problem and by the user's choice depending upon code options and hardware limitations. As in previous modular versions of REBUS, dynamic memory allocation and deallocation are performed as each modular code portion is executed.

9. COMPUTER SOFTWARE REQUIREMENTS

The code is written entirely in FORTRAN 77. The program is compiled under Lahey Fortran 95 (either Linux V 6.0c or WINDOWS Lahey Fortran 95 V5.60g). Other advanced FORTRAN compilers could be used but would require minor changes in dynamic memory management calls and clock timer routines, or anywhere else where the particular FORTRAN dialect differs from Lahey Fortran 95. The included installation procedure requires the Lahey Fortran 95 compiler. The standalone source code contains approximately 1140 subroutines and 262,000 Fortran statements. The operating system can be any of WINDOWS 95/98/2000 or newer, or any linux variation such as Red Hat Linux 7 which is compatible with the user's FORTRAN compiler.

10. REFERENCES

1. J. Hoover, G. K. Leaf, D. A. Meneley, and P. M. Walker, "The Fuel Cycle Analysis System, REBUS," Nucl. Sci. Eng. 45, p. 53, 1971.

2. A. P. Olson, J. P. Regis, D. A. Meneley, and L. J. Hoover, "A User's Manual for the Reactor Burnup System, REBUS," FRA-TM-41, Argonne National Laboratory, September 28, 1972.

3. A. P. Olson, "A User's Manual for the Reactor Burnup System, REBUS-2," FRA-TM-62, Argonne National Laboratory, March 1, 1974.

4. R. P. Hosteny, "The ARC System Fuel Cycle Analysis Capability, REBUS-2," ANL-7721, Argonne National Laboratory, October 1978.

5. B. J. Toppel, "A User's Guide for the REBUS-3 Fuel Cycle Analysis Capability," ANL-83-2, Argonne National Laboratory, 1983.

6. K. L. Derstine, "DIF3D, A Code to Solve One-, Two-, and Three-Dimensional Finite-Difference Diffusion Theory Problems," ANL-83-64, Argonne National Laboratory, 1983.

7. G. Palmiotti, E. E. Lewis, and C. B. Carrico, "VARIANT: VARIational Anistropic Nodal Transport for Multidimensional Cartesian and Hexagonal Geometry Calculation," ANL-95/40, Argonne National Laboratory, October 1995.

8. J. F. Breismeister, ed., "MCNP - A General Monte Carlo N-Particle Transport Code, Version 4B," LA-12625-M. Los Alamos National Laboratory, 1997.

9. N. A. Hanan, A. P. Olson, R. B. Pond, and J. E. Matos, "A Monte Carlo Burnup Code Linking MCNP and REBUS," presented at the 1998 International Meeting on Reduced Enrichment for Research and Test Reactors, October 18-23, Sao Paolo, Brazil.

10. R. D. O'Dell, "Standard Interface Files and Procedures for Reactor Physics Codes, Version IV," LA-6941-MS, UC-32, Los Alamos National Laboratory, September 1977.

11. CONTENTS OF CODE PACKAGE

Included are source code, sample problem data, sample problem output, code dependent BCD and binary card-image file descriptions, and Export Note.

12. DATE OF ABSTRACT

December 2001.

KEYWORDS: DEPLETION; FUEL MANAGEMENT; BURNUP; CCCC INTERFACE FORMAT; DIFFUSION THEORY; CRITICALITY CALCULATIONS; REACTOR PHYSICS; COMPLEX GEOMETRY; WORKSTATION, PC

APPENDIX II: DATASETS FOR REBUS PC V 1.4 (USING VARIANT 9.0 OF DIF3D)

```
C***********************************************************************
C                                                                     -
C                       Latest version 12/20/01                       -
C                                                                     -
CF          A.BURN                                                    -
CE          GENERAL INPUT FOR REBUS-PC V1.4 FUEL CYCLE MODULES        -
C                                                                     -
CN                        THIS BCD DATA SET MAY BE WRITTEN EITHER     -
CN                        IN FREE FORMAT (UNFORM=A.BURN) OR ACCORDING TO -
CN                        THE FORMATS SPECIFIED FOR EACH CARD TYPE     -
CN                        (DATASET=A.BURN).                            -
CN                                                                     -
CN                        COLUMNS 1-2 MUST CONTAIN THE CARD TYPE       -
CN                        NUMBER.                                      -
CN                                                                     -
CN                        A BLANK FIELD GIVES THE INDICATED DEFAULT    -
CN                        VALUE.                                       -
C                                                                     -
C                                                                     -
CN                   ***  CARD TYPE DIRECTORY  ***                     -
CN                                                                     -
CN     TYPE                    CONTENTS                                -
CN     ====     ==================================================     -
CN      01      PROBLEM TITLE                                          -
CN      02      STORAGE AND CONVERGENCE CRITERIA SPECIFICATIONS        -
CN      03      GENERAL PROBLEM DEFINITION DATA                        -
CN      04      CHARGE ENRICHMENT/CRITICALITY DATA                     -
CN      05      BURNUP TEST GROUP SPECIFICATIONS                       -
CN      06      BURNUP LIMITS                                          -
CN      07      BURNUP NUMERATOR DEFINITION                            -
CN      08      BURNUP DENOMINATOR DEFINITION                          -
CN      09      ISOTOPIC CHAIN DATA                                    -
CN      10      ACTIVE ISOTOPE LABEL EQUIVALENCE LIST                  -
CN      11      REPETITIVE FUEL MANAGEMENT PATH DATA                   -
CN      12      REACTOR CHARGE SPECIFICATIONS                          -
CN      13      FUEL FABRICATION DATA                                  -
CN      14      REACTOR DISCHARGE COOLING TIMES                        -
CN      15      REACTOR DISCHARGE DESTINATION DATA                     -
CN      16      REPROCESSING PLANT SPECIFICATIONS                      -
CN      17      RECOVERY FACTOR DATA                                   -
CN      18      CLASS SEPARATION DATA                                  -
CN      19      CLASS 1 FABRICATION SPECIFICATIONS                     -
CN      20      CLASS 2 FABRICATION SPECIFICATIONS                     -
CN      21      EXTERNAL FEED SPECIFICATIONS                           -
CN      22      EXTERNAL FEED COMPOSITION                              -
CN      23      REPROCESSING PLANT OUTPUT INITIAL COMPOSITION          -
CN      24      ACTIVE ISOTOPE DESCRIPTIONS                            -
CN      25      ACTIVE ISOTOPE DECAY CONSTANTS                         -
CN      26      ISOTOPES HAVING BURNUP DEPENDENT CROSS SECTIONS        -
CN      27      END-OF-CYCLE KEFF SEARCH DATA                          -
CN      28      AVOGADRO'S NUMBER                                      -
CN      29      SUMMARY EDITS AREA SPECIFICATIONS                      -
CN      30      SUMMARY MASS BALANCE ISOTOPE SPECIFICATIONS            -
CN      31      SUMMARY NEUTRON BALANCE ISOTOPE SPECIFICATIONS         -
CN      32      SUMMARY MASS FLOW SPECIFICATIONS 1                     -
CN      33      SUMMARY MASS FLOW SPECIFICATIONS 2                     -
CN      34      SUMMARY MASS FLOW SPECIFICATIONS 3                     -
CN      35      GENERAL FUEL MANAGEMENT SPECIFICATIONS                 -
CN      36      GENERAL FUEL MANAGEMENT PARAMETERS                     -
CN      37      GENERAL FUEL MANAGEMENT REPETITION FACTORS             -
CN      38      TIME DEPENDENT CONTROL ROD POSITIONS                   -
CN      39      BURNUP DEPENDENT GROUPS                                -
CN      40      BURNUP DEPENDENT REACTIONS                             -
CN      41      BURNUP DEPENDENT FITTING DATA SPECIFICATIONS           -
CN      42      NON-EQUILIBRIUM DISCHARGE RECOVERY FACTOR SPECIFICATIONS -
CN      43      NON-EQUILIBRIUM DISCHARGE REGION SPECIFICATIONS        -
CN      44      NON-EQUILIBRIUM FEED MODIFICATION SPECIFICATIONS       -
```

```
CN     45      FUEL MANAGEMENT GROUP SPECIFICATIONS               -
CN     46      BURNUP DEPENDENT FITTING ISOTXS LABELS             -
C                                                                 -
C*****************************************************************


C-----------------------------------------------------------------
CR            PROBLEM TITLE (TYPE 01)                             -
C                                                                 -
CL     FORMAT-----(I2,4X,11A6)                                    -
C                                                                 -
CD     COLUMNS          CONTENTS...IMPLICATIONS, IF ANY           -
CD     =======  ================================================-
CD      1-2     01                                                -
CD                                                                -
CD      7-72    ANY ALPHANUMERIC CHARACTERS.                      -
C                                                                 -
CN              AS MANY TYPE 01 CARDS MAY BE USED AS DESIRED.     -
C                                                                 -
C-----------------------------------------------------------------


C-----------------------------------------------------------------
CR           STORAGE AND CONVERGENCE CRITERIA SPECIFICATIONS (TYPE 02)  -
C                                                                 -
CL     FORMAT-----(I2,4X,3I6,3E12.5,2I6)                          -
C                                                                 -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY           -
CD  =  =======  ================================================-
CD  1  1-2      02                                                -
CD                                                                -
CD  2  7-12     POINTR AND COMMON BLOCK DEBUGGING EDITS.          -
CD             -1...COMMON BLOCKS /SINGLE/ AND /POINTS/ PRINTOUT. -
CD              0...NO DEBUGGING PRINTOUT (DEFAULT).              -
CD              1...POINTER DEBUGGING DUMP AND COMMON BLOCKS PRINTOUT. -
CD              2...POINTER DEBUGGING TRACE AND COMMON BLOCKS PRINTOUT.-
CD              3...FULL DEBUGGING PRINTOUT (TRACE + DUMP + COMMON    -
CD                                      BLOCKS PRINTOUT).         -
CD                                                                -
CD  3  13-18    POINTR CONTAINER ARRAY SIZE IN SCM IN REAL*8 WORDS. -
CD             (DEFAULT=20000).                                   -
CD                                                                -
CD  4  19-24    POINTR CONTAINER ARRAY SIZE IN LC IN REAL*8 WORDS. -
CD             (DEFAULT=0).                                       -
CD                                                                -
CD  5  25-36    CONVERGENCE CRITERION, EPSN: MAXIMUM ALLOWABLE RELATIVE-
CD              ERROR IN ANY ISOTOPE REGION DENSITY. FOR CONVERGENCE  -
CD              OF REGION-DENSITY ITERATIONS (DEFAULT=0.001).     -
CD                                                                -
CD  6  37-48    CONVERGENCE CRITERION, EPSC: MAXIMUM ALLOWABLE RELATIVE-
CD              ERROR IN ANY ISOTOPE STAGE DENSITY. FOR CONVERGENCE OF -
CD              CYCLIC MODE ITERATIONS (DEFAULT=0.001).           -
CD                                                                -
CD  7  49-60    CONVERGENCE CRITERION, EPSE: MAXIMUM ALLOWABLE RELATIVE-
CD              ERROR IN ANY ISOTOPE CHARGE DENSITY. FOR CONVERGENCE   -
CD              OF UNCONSTRAINED EQUILIBRIUM MODE (DEFAULT=0.0001). -
CD                                                                -
CD  8  61-66    MAXIMUM NUMBER OF REGION-DENSITY ITERATIONS AT A TIME  -
CD              NODE, LMAX. RECOMMENDED VALUE IS 1. LMAX IS SET TO 5   -
CD              IF INPUT VALUE IS GREATER THAN 5. IF LMAX=N, UP TO N   -
CD              NEUTRONICS SOLUTIONS WILL BE OBTAINED AT EACH TIME     -
CD              NODE (SEE CARD TYPE 03). LMAX=0 MEANS NO AVERAGING OF  -
CD              THE BURN MATRIX WILL BE DONE. THIS VALUE SHOULD NOT BE -
CD              USED FOR EQUILIBRIUM PROBLEMS. IF NO TYPE 02 CARD IS   -
CD              SUPPLIED, OR IF THIS IS AN EQUILIBRIUM PROBLEM, A      -
CD              DEFAULT VALUE OF 1 WILL BE USED.                  -
CD                                                                -
CD  9  67-72    MAXIMUM NUMBER OF CYCLIC MODE ITERATIONS, MMAX.   -
CD             (DEFAULT=1).                                       -
C                                                                 -
CN              FOR NONEQUILIBRIUM PROBLEMS, SET EPSC=EPSE=1.000. -
CN              PROBLEMS INVOLVING HIGH FUEL BURNUP (GREATER THAN -
```

19

```
CN              ABOUT 20 ATOM PER CENT) SHOULD USE 2 CYCLIC MODE      -
CN              ITERATIONS (COLS 67-72).  VERY HIGH DISCHARGE BURNUP  -
CN              (GREATER THAN ABOUT 50 ATOM PER CENT) MAY REQUIRE MORE -
CN              THAN 2 CYCLIC MODE ITERATIONS.                        -
C                                                                     -
CN              IF COLS. 61-66 ARE NEGATIVE, NO REGION DENSITY        -
CN              EXTRAPOLATIONS WILL BE PERFORMED.  NORMALLY, THE       -
CN              REGION DENSITIES ARE EXTRAPOLATED AFTER THE 2ND AND    -
CN              4TH END OF BURN STEP NEUTRONICS HAVE BEEN PERFORMED    -
CN              TO ATTEMPT TO ACCELERATE THE PROBLEM.  HOWEVER, IT HAS -
CN              BEEN OBSERVED THAT FOR SOME PROBLEMS, THE EXTRAPOLATION-
CN              PROCEDURE OUTLINED IN ANL-7721 ON PP. 51-52 LEADS TO   -
CN              ERRONEOUS VALUES FOR THE REGION DENSITIES.  IN FACT,   -
CN              NEGATIVE REGION DENSITIES HAVE BEEN GENERATED IN SOME  -
CN              PROBLEMS.  SETTING COLS. 61-66 TO THE NEGATIVE NUMBER  -
CN              OF REGION-DENSITY ITERATIONS TO BE PERFORMED WILL      -
CN              AVOID THESE PROBLEMS.                                 -
C                                                                     -
C---------------------------------------------------------------------


C---------------------------------------------------------------------
CR             GENERAL PROBLEM DEFINITION DATA (TYPE 03)             -
C                                                                     -
CL     FORMAT-----(I2,4X,I6,4E12.5,2I6)                               -
C                                                                     -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY             -
CD  =  ======  ======================================================-
CD  1  1-2     03                                                     -
CD                                                                    -
CD  2  7-12    NUMBER OF PREVIOUS BURN CYCLES.                        -
CD                                                                    -
CD  3  13-24   SHUTDOWN TIME BETWEEN BURN CYCLES (IN DAYS).           -
CD             (NONEQUILIBRIUM PROBLEMS ONLY).                        -
CD                                                                    -
CD  4  25-36   TIME AT WHICH PROBLEM BEGINS (IN DAYS).                -
CD                                                                    -
CD  5  37-48   INITIAL TOTAL BURN CYCLE TIME GUESS (IN DAYS).         -
CD                                                                    -
CD  6  49-60   CONVERGENCE CRITERION, EPSG: ACTUAL ERROR ALLOWABLE    -
CD             IN BURNUP (SEE CARD TYPE 06 AND NOTE BELOW).           -
CD             (DEFAULT=0.001).                                       -
CD                                                                    -
CD  7  61-66   NUMBER OF SUBINTERVALS INTO WHICH THE TOTAL BURN CYCLE -
CD             TIME IS TO BE DIVIDED.                                 -
CD                                                                    -
CD  8  67-72   NUMBER OF FUEL MANAGEMENT OPERATIONS, FOR              -
CD             NONEQUILIBRIUM PROBLEMS ONLY. THIS VALUE IS 1 LESS     -
CD             THAN THE TOTAL NUMBER OF BURN CYCLES WHICH WILL BE     -
CD             COMPUTED.                                              -
C                                                                     -
CN             THE DATA CARDS OF A.BURN MAY BE DIVIDED INTO THE       -
CN             FOLLOWING FUNCTIONAL GROUPS:                           -
CN                                              CARD TYPES            -
CN                   FUNCTION             REQUIRED        OPTIONAL    -
CN             ======================== ===============  ==========-
CN             BASIC (NONEQUIL.) PROBLEM 03,09,11(35),24  01,02,10,25-
CN                                                                    -
CN             CHARGE ENRICHMENT SEARCH   04                         -
CN             + REQUIRED EXTERNAL CYCLE  12,13,18-22        --       -
CN                                                                    -
CN             BURNUP LIMITS              06               05,07,08   -
CN                                                                    -
CN             REPROCESSING PLANTS        15,16,17         14,23      -
CN                                                                    -
CN             IF THE FUEL MANAGEMENT IS SPECIFIED USING THE TYPE 35  -
CN             CARDS RATHER THAN THE TYPE 11 CARDS, CARD TYPES        -
CN             14, 15, 16, 17, AND 23 SHOULD NOT BE SUPPLIED.         -
CN                                                                    -
CN             THE TWO BASIC TYPES OF PROBLEMS WHICH MAY BE RUN ARE   -
CN             EQUILIBRIUM AND NONEQUILIBRIUM. AN EQUILIBRIUM PROBLEM -
CN             IS DEFINED AS ONE IN WHICH THE USER WISHES TO FIND THE -
```

```
CN                    OPERATING CONDITIONS OF THE SPECIFIED REACTOR AFTER AN -
CN                    INFINITE NUMBER OF BURN/DISCHARGE/REFUEL STEPS WITH    -
CN                    THE CONDITIONS AND CONSTRAINTS AS SUPPLIED. SUCH       -
CN                    PROBLEMS REQUIRE THE BASIC PROBLEM CARDS, THE CHARGE   -
CN                    ENRICHMENT SEARCH AND EXTERNAL CYCLE CARDS, AND THE    -
CN                    SPECIFICATION OF AT LEAST ONE BURNUP LIMIT.            -
CN                    OPTIONALLY, ONE MAY INCLUDE REPROCESSING PLANTS IN THE -
CN                    EXTERNAL CYCLE. A NONEQUILIBRIUM PROBLEM, ON THE OTHER -
CN                    HAND, IS ONE IN WHICH THE BURN/REFUEL STEPS ARE        -
CN                    EXPLICITLY COMPUTED IN SUCCESSION USING THE SUPPLIED   -
CN                    PARAMETERS AND CONSTRAINTS. SUCH PROBLEMS REQUIRE ONLY -
CN                    THE BASIC PROBLEM CARD TYPES LISTED ABOVE. OPTIONALLY, -
CN                    ONE MAY SPECIFY AN ENRICHMENT SEARCH BY INCLUDING CARD -
CN                    TYPE 04 AND THE REQUIRED EXTERNAL CYCLE CARDS. IF SUCH -
CN                    A SEARCH IS SPECIFIED, ONE MAY ALSO SPECIFY DESIRED    -
CN                    BURNUP LIMITS BY INCLUDING THE APPROPRIATE CARDS.      -
CN                                                                          -
CN                    THE TOTAL BURN CYCLE TIME MAY BE DIVIDED INTO A NUMBER -
CN                    OF EQUAL SUBINTERVALS, AS GIVEN IN COLS. 61-66 OF THIS -
CN                    CARD. FLUX DISTRIBUTIONS WILL BE COMPUTED AT TIME ZERO -
CN                    AND AT THE END OF EACH OF THESE SUBINTERVALS. EACH     -
CN                    SUCH POINT IS CALLED A TIME NODE. A PROBLEM WITH N     -
CN                    SUBINTERVALS THUS HAS N+1 TIME NODES. IF CONTROL       -
CN                    MATERIALS ARE PRESENT, THE APPROPRIATE CONTROL SEARCHES-
CN                    MAY BE CARRIED OUT TO MAINTAIN A PRESCRIBED KEFF AT    -
CN                    EACH OF THESE TIME NODES. (SEE CARD TYPES 21, 22       -
CN                    AND 23 OF DATA SET A.NIP3).                            -
CN                                                                          -
CN                    FOR EQUILIBRIUM PROBLEMS, A MAXIMUM OF FOUR            -
CN                    SUBINTERVALS IS ALLOWED. THERE IS NO LIMIT FOR         -
CN                    NONEQUILIBRIUM PROBLEMS.                               -
CN                                                                          -
CN                    NOTE: IF COLS. 49-60 ARE NON-NEGATIVE, THE BURNUP WILL -
CN                    BE DEFINED AS THE RATIO OF FISSIONABLE ATOMS DESTROYED -
CN                    BY FISSION IN THE DISCHARGED FUEL TO THE TOTAL         -
CN                    FISSIONABLE ATOMS INITIALLY PRESENT IN THE FUEL.  IF   -
CN                    COLS. 49-60 ARE NEGATIVE, THE BURNUP WILL BE DEFINED   -
CN                    AS THE RATIO OF FISSIONABLE ATOMS DESTROYED BY ALL     -
CN                    PROCESSES IN THE DISCHARGED FUEL TO THE TOTAL          -
CN                    FISSIONABLE ATOMS INITIALLY PRESENT IN THE FUEL, AND   -
CN                    THE ABSOLUTE VALUE OF COLS. 49-60 WILL BE USED FOR     -
CN                    EPSG.  FISSIONABLE ISOTOPES ARE THOSE ACTIVE ISOTOPES  -
CN                    WHICH APPEAR ON A CARD TYPE 09 WITH A 2 IN COLS. 13-18.-
C                                                                          -
C------------------------------------------------------------------------


C------------------------------------------------------------------------
CR           CHARGE ENRICHMENT/CRITICALITY DATA (TYPE 04)              -
C                                                                          -
CL    FORMAT-----(I2,10X,5E12.5)                                           -
C                                                                          -
CD  #   COLUMNS            CONTENTS...IMPLICATIONS, IF ANY                -
CD  =   =======   ========================================================-
CD  1   1-2       04                                                       -
CD                                                                        -
CD  2   13-24     DESIRED UNPOISONED KEFF(0).                             -
CD                                                                        -
CD  3   25-36     CONVERGENCE CRITERION, EPSF: RELATIVE ERROR ALLOWABLE   -
CD                IN KEFF(0) DURING CHARGE ENRICHMENT SEARCHES            -
CD                (DEFAULT=0.001).                                        -
CD                                                                        -
CD  4   37-48     FRACTION OF TOTAL BURN TIME AT WHICH KEFF(0) IS TO BE   -
CD                REACHED. THIS MUST BE ONE OF THE END POINTS OF A        -
CD                SUBINTERVAL OF THE BURN STEP, I.E. A TIME NODE.         -
CD                                                                        -
CD  5   49-60     INITIAL VALUE FOR THE CHARGE ENRICHMENT                 -
CD                SEARCH PARAMETER X.                                     -
CD                                                                        -
CD  6   61-72     SECOND VALUE FOR THE CHARGE ENRICHMENT                  -
CD                SEARCH PARAMETER X. (DEFAULT=INITIAL VALUE FROM         -
CD                COLS.49-60 PLUS 0.1).                                   -
```

21

```
C                                                                        -
CN            THE ENRICHMENT OF A BATCH OF FRESH FUEL IDENTIFIED          -
CN            AS CHARGE TYPE M IS ADJUSTED ACCORDING TO THE FORMULA       -
CN                      E(M)=E(M)(0)(1+(X-1.)*DELTA(M)),                   -
CN            WHERE X IS THE CHARGE ENRICHMENT SEARCH PARAMETER           -
CN            WHOSE INITIAL VALUE IS GIVEN IN COLS. 49-60.                -
CN            THE E(M)(0) AND DELTA(M) FOR EACH CHARGE TYPE ARE           -
CN            SPECIFIED ON CARD TYPE 12. RESULTING VALUE OF E(M)          -
CN            MUST ALWAYS LIE BETWEEN 0 AND 1.                            -
CN                                                                        -
CN            IF CARD TYPE 04 IS SUPPLIED, ALL "REQUIRED EXTERNAL         -
CN            CYCLE" CARDS MUST BE INCLUDED (SEE DISCUSSION IN CARD       -
CN            TYPE 03).                                                   -
CN                                                                        -
CN            IN THE FOLLOWING CARDS, A "LABEL" WILL BE IDENTIFIED        -
CN            FROM THE CARD TYPE (E.G., CARD TYPE 21 INDICATES THAT       -
CN            EXTERNAL FEED DATA ARE TO FOLLOW). A LABEL IS DEFINED       -
CN            AS A SIX-CHARACTER IDENTIFIER THAT REFERENCES THE           -
CN            SPECIFIC OPERATIONS OR DATA THAT FOLLOW. FOR EXAMPLE,       -
CN            A "PATH" LABEL DEFINES A SPECIFIC SEQUENCE OF SPATIAL       -
CN            POSITIONS AND MOTIONS OF A "CHARGE" IN THE REACTOR          -
CN            AS LISTED ON THE CARD.                                      -
CN                                                                        -
CN            THE ISOTOPE LABELING SYSTEM ALLOWS DIFFERENT LIBRARY        -
CN            LABELS (I.E., DIFFERENT MICROSCOPIC CROSS SECTIONS) TO      -
CN            BE USED IN DIFFERENT FUEL BATCHES. THE INTERNAL, OR         -
CN            RUN-TIME, LABELS FOR "ACTIVE" ISOTOPES (THOSE THAT ARE      -
CN            INCLUDED IN THE TRANSMUTATION MATRIX) ARE DEFINED           -
CN            IN THE SPECIFICATION OF THE ISOTOPIC CHAIN (CARD TYPE       -
CN            09). THESE RUN-TIME LABELS MAY COINCIDE WITH THE            -
CN            LIBRARY LABELS FOR ALL MATERIALS, IN WHICH CASE NO          -
CN            FUTHER INPUT IS REQUIRED. THE USER MAY, HOWEVER,            -
CN            SPECIFY (SEE CARD TYPE 10) THAT A LIBRARY ISOTOPE           -
CN            LABEL (WHICH DEFINES APPROPRIATE CROSS SECTIONS FOR         -
CN            SOME FUEL BATCH) IS EQUIVALENT TO ONE OF THOSE              -
CN            SPECIFIED ON CARD TYPE 09. ALL LIBRARY ISOTOPES THAT        -
CN            ARE EQUIVALENCED TO ONE OF THESE RUN-TIME LABELS ARE        -
CN            CONSIDERED IDENTICAL IN THE EXTERNAL CYCLE.                 -
CN            APPROPRIATE MICROSCOPIC CROSS SECTIONS FOR THE FRESH        -
CN            CHARGE BATCHES ARE SELECTED THROUGH THE FUEL               -
CN            FABRICATION DATA ON CARD TYPE 13. ACTIVE ISOTOPE            -
CN            LABELS APPEARING ON CARD TYPES OTHER THAN 10 OR 13          -
CN            MUST BE THOSE THAT APPEAR IN COLS. 7-12 OF THE TYPE         -
CN            09 CARDS OR VIA THE PRESTORED BURNUP CHAINS (SEE CARD       -
CN            TYPE 09).                                                   -
C                                                                        -
C------------------------------------------------------------------------


C------------------------------------------------------------------------
CR            BURNUP TEST GROUP SPECIFICATIONS (TYPE 05)                  -
C                                                                        -
CL     FORMAT-----(I2,4X,11A6)                                           -
C                                                                        -
CD   #   COLUMNS            CONTENTS...IMPLICATIONS, IF ANY               -
CD   =   =======  =========================================================-
CD   1   1-2      05                                                      -
CD                                                                        -
CD   2   7-12     LABEL OF BURNUP TEST GROUP (REPEATED ON ADDITIONAL      -
CD                CARDS).                                                 -
CD                                                                        -
CD   3   13-18    PATH LABEL (SEE CARD TYPE 11 OR CARD TYPE 35) TO BE     -
CD                INCLUDED IN TEST GROUP. SEE NOTE FOLLOWING CARD TYPE 06-
CD                                                                        -
CD   4   19-24    PATH LABEL (SEE CARD TYPE 11 OR CARD TYPE 35) TO BE     -
CD                INCLUDED IN TEST GROUP. SEE NOTE FOLLOWING CARD TYPE 06-
CD                                                                        -
CD   5   25-30    PATH LABEL (SEE CARD TYPE 11 OR CARD TYPE 35) TO BE     -
CD                INCLUDED IN TEST GROUP. SEE NOTE FOLLOWING CARD TYPE 06-
CD                                                                        -
CD   6   31-36    PATH LABEL (SEE CARD TYPE 11 OR CARD TYPE 35) TO BE     -
CD                INCLUDED IN TEST GROUP. SEE NOTE FOLLOWING CARD TYPE 06-
```

22

```
CD                                                                      -
CD  7   37-42   PATH LABEL (SEE CARD TYPE 11 OR CARD TYPE 35) TO BE   -
CD              INCLUDED IN TEST GROUP. SEE NOTE FOLLOWING CARD TYPE 06-
CD                                                                      -
CD  8   43-48   PATH LABEL (SEE CARD TYPE 11 OR CARD TYPE 35) TO BE   -
CD              INCLUDED IN TEST GROUP. SEE NOTE FOLLOWING CARD TYPE 06-
CD                                                                      -
CD  9   49-54   PATH LABEL (SEE CARD TYPE 11 OR CARD TYPE 35) TO BE   -
CD              INCLUDED IN TEST GROUP. SEE NOTE FOLLOWING CARD TYPE 06-
CD                                                                      -
CD 10   55-60   PATH LABEL (SEE CARD TYPE 11 OR CARD TYPE 35) TO BE   -
CD              INCLUDED IN TEST GROUP. SEE NOTE FOLLOWING CARD TYPE 06-
CD                                                                      -
CD 11   61-66   PATH LABEL (SEE CARD TYPE 11 OR CARD TYPE 35) TO BE   -
CD              INCLUDED IN TEST GROUP. SEE NOTE FOLLOWING CARD TYPE 06-
CD                                                                      -
CD 12   67-72   PATH LABEL (SEE CARD TYPE 11 OR CARD TYPE 35) TO BE   -
CD              INCLUDED IN TEST GROUP. SEE NOTE FOLLOWING CARD TYPE 06-
C                                                                       -
CN              USERS SHOULD NORMALLY ORDER THE PATH LABELS IN COLS.  -
CN              13-18 SO THAT THEY AGREE WITH THE ORDER SPECIFIED ON  -
CN              THE TYPE 11 OR 35 CARDS TO AVOID AN OBSCURE CODING BUG -
CN              WHICH OCCURS FOR CERTAIN INPUT SITUATIONS.            -
C                                                                       -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR              BURNUP LIMITS (TYPE 06)                               -
C                                                                       -
CL     FORMAT-----(I2,10X,3(A6,E12.5))                                -
C                                                                       -
CD  #   COLUMNS          CONTENTS...IMPLICATIONS, IF ANY              -
CD  =   =======   =======================================================-
CD  1   1-2       06                                                   -
CD                                                                      -
CD  2   13-18     TEST GROUP OR PATH LABEL.                            -
CD                                                                      -
CD  3   19-30     DISCHARGE BURNUP LIMIT (AS DECIMAL FRACTION).        -
CD                                                                      -
CD  4   31-36     TEST GROUP OR PATH LABEL.                            -
CD                                                                      -
CD  5   37-48     DISCHARGE BURNUP LIMIT (AS DECIMAL FRACTION).        -
CD                                                                      -
CD  6   49-54     TEST GROUP OR PATH LABEL.                            -
CD                                                                      -
CD  7   55-66     DISCHARGE BURNUP LIMIT (AS DECIMAL FRACTION).        -
C                                                                       -
CN                                                                     -
CN              NOTE THAT TYPE 06 CARDS MUST NOT BE SUPPLIED IF THE   -
CN              PROBLEM DOES NOT IN FACT REQUIRE A BURNUP SEARCH.     -
CN              TYPICALLY, NONEQUILIBRIUM PROBLEMS SHOULD NOT HAVE    -
CN              TYPE 06 CARDS.                                         -
CN                                                                     -
CN              EACH BURNUP LIMIT REFERS TO THE RATIO OF THE TOTAL    -
CN              NUMBER OF ATOMS DESTROYED (ACCORDING TO THE SIGN OF   -
CN              THE DATA IN COLS. 49-60 ON CARD TYPE 03) IN THE       -
CN              DISCHARGED FUEL TO THE TOTAL ATOMS INITIALLY PRESENT  -
CN              IN THE FUEL.                                           -
CN              UNLESS SPECIFIED OTHERWISE (SEE CARD TYPES 07 AND 08), -
CN              THE NUMERATOR OF THIS RATIO INCLUDES REACTIONS FOR ALL -
CN              FISSIONABLE ISOTOPES OCCURING OVER THE BURN CYCLE, AND -
CN              THE DENOMINATOR INCLUDES ALL FISSIONABLE ATOMS PRESENT -
CN              AT THE START OF THE BURN CYCLE.                        -
CN                                                                     -
CN              A BURNUP LIMIT MAY BE SPECIFIED FOR A TEST GROUP,     -
CN              CONSISTING OF A COLLECTION OF SEVERAL PATHS AS        -
CN              SPECIFIED ON TYPE 05 CARDS, AND/OR A SINGLE PATH. FOR -
CN              TEST GROUPS A SINGLE AVERAGE BURNUP IS COMPUTED WHILE -
CN              FOR A PATH LABEL A SEPARATE BURNUP IS COMPUTED FOR    -
CN              EACH MATERIAL TYPE TO WHICH THAT PATH APPLIES. IF NO  -
CN              BURNUP LIMIT IS GIVEN, NO BURNUP TEST IS MADE FOR THAT -
```

```
CN                    PATH OR TEST GROUP.                            -
CN                                                                   -
CN                    WE DEFINE THE RELATIVE BURNUP ERROR AS THE VALUE OF    -
CN                    THE DIFFERENCE BETWEEN ALLOWABLE AND ACHIEVED BURNUP   -
CN                    RELATIVE TO THE ALLOWABLE BURNUP. THAT PATH OR TEST    -
CN                    GROUP WHICH COMES CLOSEST TO OR MOST EXCEEDS ITS       -
CN                    BURNUP LIMIT IS THE ONE WHICH HAS THE SMALLEST         -
CN                    RELATIVE BURNUP, I.E., THE MINIMUM OF                  -
CN                       (BURNUP ALLOWED - BURNUP ACHIEVED)/BURNUP ALLOWED   -
CN                    OVER ALL PATHS OR TEST GROUPS. DENOTING THIS LIMITING  -
CN                    PATH OR TEST GROUP BY M, THE TOTAL BURN CYCLE TIME     -
CN                    WILL BE ADJUSTED UNTIL THE ACTUAL BURNUP OF M IS       -
CN                    WITHIN PLUS OR MINUS EPSG OF THE ALLOWABLE BURNUP      -
CN                    LIMIT SPECIFIED ON THE TYPE 06 CARD, I.E., UNTIL       -
CN                    (BURNUP ALLOWED-BURNUP ACHIEVED)=0 PLUS OR MINUS EPSG. -
CN                    THIS WILL GIVE THE LONGEST BURN CYCLE TIME FOR WHICH   -
CN                    ALL PATHS AND/OR TEST GROUPS REMAIN WITHIN THEIR       -
CN                    RESPECTIVE BURNUP LIMITS.                              -
CN                                                                   -
CN                    SETTING EPSG (COLS. 49-60 ON CARD TYPE 03) TO A LARGE  -
CN                    NUMBER WILL ALLOW THE BURNUPS TO BE COMPUTED BUT WILL  -
CN                    PREVENT ANY ADJUSTMENT OF THE BURN CYCLE TIME.         -
C                                                                    -
C--------------------------------------------------------------------


C--------------------------------------------------------------------
CR            BURNUP NUMERATOR DEFINITION (TYPE 07)                  -
C                                                                    -
CL     FORMAT-----(I2,4X,11A6)                                       -
C                                                                    -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY            -
CD  =  =======  ========================================================-
CD  1  1-2      07                                                   -
CD                                                                   -
CD  2  7-12     TEST GROUP OR PATH LABEL (REPEATED ON ADDITIONAL     -
CD              CARDS, IF NECESSARY).                                -
CD                                                                   -
CD  3  13-18    LABEL OF FISSIONABLE ISOTOPE TO BE INCLUDED IN       -
CD              NUMERATOR OF BURNUP EXPRESSION FOR THE SPECIFIED     -
CD              TEST GROUP OR PATH. (NOTE: THIS IS A LABEL FROM      -
CD              COLS. 7-12 OF THE ACTIVE CHAIN SPECIFIED ON CARD     -
CD              TYPE 09 OR IN A PRESTORED BURNUP CHAIN.)             -
CD                                                                   -
CD  4  19-24    LABEL OF FISSIONABLE ISOTOPE TO BE INCLUDED IN       -
CD              NUMERATOR OF BURNUP EXPRESSION FOR THE SPECIFIED     -
CD              TEST GROUP OR PATH. (NOTE: THIS IS A LABEL FROM      -
CD              COLS. 7-12 OF THE ACTIVE CHAIN SPECIFIED ON CARD     -
CD              TYPE 09 OR IN A PRESTORED BURNUP CHAIN.)             -
CD                                                                   -
CD  5  25-30    LABEL OF FISSIONABLE ISOTOPE TO BE INCLUDED IN       -
CD              NUMERATOR OF BURNUP EXPRESSION FOR THE SPECIFIED     -
CD              TEST GROUP OR PATH. (NOTE: THIS IS A LABEL FROM      -
CD              COLS. 7-12 OF THE ACTIVE CHAIN SPECIFIED ON CARD     -
CD              TYPE 09 OR IN A PRESTORED BURNUP CHAIN.)             -
CD                                                                   -
CD  6  31-36    LABEL OF FISSIONABLE ISOTOPE TO BE INCLUDED IN       -
CD              NUMERATOR OF BURNUP EXPRESSION FOR THE SPECIFIED     -
CD              TEST GROUP OR PATH. (NOTE: THIS IS A LABEL FROM      -
CD              COLS. 7-12 OF THE ACTIVE CHAIN SPECIFIED ON CARD     -
CD              TYPE 09 OR IN A PRESTORED BURNUP CHAIN.)             -
CD                                                                   -
CD  7  37-42    LABEL OF FISSIONABLE ISOTOPE TO BE INCLUDED IN       -
CD              NUMERATOR OF BURNUP EXPRESSION FOR THE SPECIFIED     -
CD              TEST GROUP OR PATH. (NOTE: THIS IS A LABEL FROM      -
CD              COLS. 7-12 OF THE ACTIVE CHAIN SPECIFIED ON CARD     -
CD              TYPE 09 OR IN A PRESTORED BURNUP CHAIN.)             -
CD                                                                   -
CD  8  43-48    LABEL OF FISSIONABLE ISOTOPE TO BE INCLUDED IN       -
CD              NUMERATOR OF BURNUP EXPRESSION FOR THE SPECIFIED     -
CD              TEST GROUP OR PATH. (NOTE: THIS IS A LABEL FROM      -
CD              COLS. 7-12 OF THE ACTIVE CHAIN SPECIFIED ON CARD     -
```

```
CD                 TYPE 09 OR IN A PRESTORED BURNUP CHAIN.)        -
CD                                                                 -
CD  9  49-54      LABEL OF FISSIONABLE ISOTOPE TO BE INCLUDED IN   -
CD                 NUMERATOR OF BURNUP EXPRESSION FOR THE SPECIFIED -
CD                 TEST GROUP OR PATH. (NOTE: THIS IS A LABEL FROM  -
CD                 COLS. 7-12 OF THE ACTIVE CHAIN SPECIFIED ON CARD -
CD                 TYPE 09 OR IN A PRESTORED BURNUP CHAIN.)        -
CD                                                                 -
CD 10  55-60      LABEL OF FISSIONABLE ISOTOPE TO BE INCLUDED IN   -
CD                 NUMERATOR OF BURNUP EXPRESSION FOR THE SPECIFIED -
CD                 TEST GROUP OR PATH. (NOTE: THIS IS A LABEL FROM  -
CD                 COLS. 7-12 OF THE ACTIVE CHAIN SPECIFIED ON CARD -
CD                 TYPE 09 OR IN A PRESTORED BURNUP CHAIN.)        -
CD                                                                 -
CD 11  61-66      LABEL OF FISSIONABLE ISOTOPE TO BE INCLUDED IN   -
CD                 NUMERATOR OF BURNUP EXPRESSION FOR THE SPECIFIED -
CD                 TEST GROUP OR PATH. (NOTE: THIS IS A LABEL FROM  -
CD                 COLS. 7-12 OF THE ACTIVE CHAIN SPECIFIED ON CARD -
CD                 TYPE 09 OR IN A PRESTORED BURNUP CHAIN.)        -
CD                                                                 -
CD 12  67-72      LABEL OF FISSIONABLE ISOTOPE TO BE INCLUDED IN   -
CD                 NUMERATOR OF BURNUP EXPRESSION FOR THE SPECIFIED -
CD                 TEST GROUP OR PATH. (NOTE: THIS IS A LABEL FROM  -
CD                 COLS. 7-12 OF THE ACTIVE CHAIN SPECIFIED ON CARD -
CD                 TYPE 09 OR IN A PRESTORED BURNUP CHAIN.)        -
C                                                                  -
CN                 IF THIS CARD IS PRESENT, ONLY FISSION REACTIONS OF -
CN                 ISOTOPES APPEARING IN THIS LIST CONTRIBUTE TOWARD -
CN                 THE CALCULATION OF THE BURNUP NUMERATOR OF THE TEST -
CN                 GROUP OR PATH SPECIFIED IN COLS. 7-12.          -
C                                                                  -
C-------------------------------------------------------------------


C-------------------------------------------------------------------
CR           BURNUP DENOMINATOR DEFINITION (TYPE 08)               -
C                                                                  -
CL    FORMAT-----(I2,4X,11A6)                                      -
C                                                                  -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY           -
CD  =  =======  =========================================================-
CD  1  1-2       08                                                -
CD                                                                 -
CD  2  7-12      TEST GROUP OR PATH LABEL (REPEATED ON ADDITIONAL  -
CD                 CARDS, IF NECESSARY).                            -
CD                                                                 -
CD  3  13-18     LABEL OF ACTIVE ISOTOPE TO BE INCLUDED IN DENOMINATOR -
CD                 OF BURNUP EXPRESSION FOR THE SPECIFIED TEST GROUP OR -
CD                 PATH. (NOTE: THIS IS A LABEL FROM COLS. 7-12 OF THE -
CD                 ACTIVE CHAIN SPECIFIED ON CARD TYPE 09 OR IN A  -
CD                 PRESTORED BURNUP CHAIN.)                         -
CD                                                                 -
CD  4  19-24     LABEL OF ACTIVE ISOTOPE TO BE INCLUDED IN DENOMINATOR -
CD                 OF BURNUP EXPRESSION FOR THE SPECIFIED TEST GROUP OR -
CD                 PATH. (NOTE: THIS IS A LABEL FROM COLS. 7-12 OF THE -
CD                 ACTIVE CHAIN SPECIFIED ON CARD TYPE 09 OR IN A  -
CD                 PRESTORED BURNUP CHAIN.)                         -
CD                                                                 -
CD  5  25-30     LABEL OF ACTIVE ISOTOPE TO BE INCLUDED IN DENOMINATOR -
CD                 OF BURNUP EXPRESSION FOR THE SPECIFIED TEST GROUP OR -
CD                 PATH. (NOTE: THIS IS A LABEL FROM COLS. 7-12 OF THE -
CD                 ACTIVE CHAIN SPECIFIED ON CARD TYPE 09 OR IN A  -
CD                 PRESTORED BURNUP CHAIN.)                         -
CD                                                                 -
CD  6  31-36     LABEL OF ACTIVE ISOTOPE TO BE INCLUDED IN DENOMINATOR -
CD                 OF BURNUP EXPRESSION FOR THE SPECIFIED TEST GROUP OR -
CD                 PATH. (NOTE: THIS IS A LABEL FROM COLS. 7-12 OF THE -
CD                 ACTIVE CHAIN SPECIFIED ON CARD TYPE 09 OR IN A  -
CD                 PRESTORED BURNUP CHAIN.)                         -
CD                                                                 -
CD  7  37-42     LABEL OF ACTIVE ISOTOPE TO BE INCLUDED IN DENOMINATOR -
CD                 OF BURNUP EXPRESSION FOR THE SPECIFIED TEST GROUP OR -
```

```
CD               PATH. (NOTE: THIS IS A LABEL FROM COLS. 7-12 OF THE    -
CD               ACTIVE CHAIN SPECIFIED ON CARD TYPE 09 OR IN A         -
CD               PRESTORED BURNUP CHAIN.)                               -
CD                                                                      -
CD  8   43-48    LABEL OF ACTIVE ISOTOPE TO BE INCLUDED IN DENOMINATOR  -
CD               OF BURNUP EXPRESSION FOR THE SPECIFIED TEST GROUP OR   -
CD               PATH. (NOTE: THIS IS A LABEL FROM COLS. 7-12 OF THE    -
CD               ACTIVE CHAIN SPECIFIED ON CARD TYPE 09 OR IN A         -
CD               PRESTORED BURNUP CHAIN.)                               -
CD                                                                      -
CD  9   49-54    LABEL OF ACTIVE ISOTOPE TO BE INCLUDED IN DENOMINATOR  -
CD               OF BURNUP EXPRESSION FOR THE SPECIFIED TEST GROUP OR   -
CD               PATH. (NOTE: THIS IS A LABEL FROM COLS. 7-12 OF THE    -
CD               ACTIVE CHAIN SPECIFIED ON CARD TYPE 09 OR IN A         -
CD               PRESTORED BURNUP CHAIN.)                               -
CD                                                                      -
CD  10  55-60    LABEL OF ACTIVE ISOTOPE TO BE INCLUDED IN DENOMINATOR  -
CD               OF BURNUP EXPRESSION FOR THE SPECIFIED TEST GROUP OR   -
CD               PATH. (NOTE: THIS IS A LABEL FROM COLS. 7-12 OF THE    -
CD               ACTIVE CHAIN SPECIFIED ON CARD TYPE 09 OR IN A         -
CD               PRESTORED BURNUP CHAIN.)                               -
CD                                                                      -
CD  11  61-66    LABEL OF ACTIVE ISOTOPE TO BE INCLUDED IN DENOMINATOR  -
CD               OF BURNUP EXPRESSION FOR THE SPECIFIED TEST GROUP OR   -
CD               PATH. (NOTE: THIS IS A LABEL FROM COLS. 7-12 OF THE    -
CD               ACTIVE CHAIN SPECIFIED ON CARD TYPE 09 OR IN A         -
CD               PRESTORED BURNUP CHAIN.)                               -
CD                                                                      -
CD  12  67-72    LABEL OF ACTIVE ISOTOPE TO BE INCLUDED IN DENOMINATOR  -
CD               OF BURNUP EXPRESSION FOR THE SPECIFIED TEST GROUP OR   -
CD               PATH. (NOTE: THIS IS A LABEL FROM COLS. 7-12 OF THE    -
CD               ACTIVE CHAIN SPECIFIED ON CARD TYPE 09 OR IN A         -
CD               PRESTORED BURNUP CHAIN.)                               -
C                                                                      -
CN               IF THIS CARD IS PRESENT, ONLY ISOTOPES APPEARING IN    -
CN               THIS LIST CONTRIBUTE TOWARD THE CALCULATION OF THE     -
CN               BURNUP DENOMINATOR OF THE TEST GROUP OR PATH SPECIFIED -
CN               IN COLS. 7-12.                                         -
C                                                                      -
C----------------------------------------------------------------------


C----------------------------------------------------------------------
CR          ISOTOPIC CHAIN DATA (TYPE 09)                          -
C                                                                      -
CL    FORMAT-----(I2,4X,A6,I6,3(A6,E12.5))                             -
C                                                                      -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY               -
CD  =  =======  =========================================================-
CD  1  1-2      09                                                     -
CD                                                                     -
CD  2  7-12     LABEL OF ISOTOPE UNDERGOING REACTION (REPEATED ON ALL  -
CD               CARDS THAT SPECIFY OTHER REACTIONS FOR THIS ISOTOPE)  -
CD               OR ONE OF THE PRIVILEGED LABELS PUUCH1, PUUCH2, THUCH1,-
CD               OR THUCH2 SPECIFYING ONE OF THE PRESTORED BURNUP      -
CD               CHAINS.                                               -
CD                                                                     -
CD  3  13-18    REACTION TYPE (REPEATED ON ADDITIONAL CARDS,          -
CD               IF NECESSARY).                                        -
CD               0...NO REACTION.                                      -
CD               1...(N,GAMMA) REACTION.                               -
CD               2...(N,F) REACTION.                                   -
CD               3...(N,P) REACTION.                                   -
CD               4...(N,ALPHA) REACTION.                               -
CD               5...(N,2N) REACTION.                                  -
CD               6...BETA-MINUS DECAY.                                 -
CD               7...BETA-PLUS DECAY.                                  -
CD               8...ALPHA DECAY.                                      -
CD               9...(N,D) REACTION.                                   -
CD              10...(N,T) REACTION.                                   -
CD                                                                     -
CD  4  19-24    LABEL OF PRODUCT ISOTOPE FROM THE REACTION SPECIFIED   -
```

26

```
CD              IN COLS. 13-18 OR THE PRIVILEGED LABEL DELETE.        -
CD                                                                   -
CD  5   25-36   YIELD FRACTION OR ISOMERIC STATE BRANCHING FRACTION  -
CD              TO THE ISOTOPE SPECIFIED IN COLS. 19-24.             -
CD                                                                   -
CD  6   37-42   LABEL OF PRODUCT ISOTOPE FROM THE REACTION SPECIFIED -
CD              IN COLS. 13-18.                                      -
CD                                                                   -
CD  7   43-54   YIELD FRACTION OR ISOMERIC STATE BRANCHING FRACTION  -
CD              TO THE ISOTOPE SPECIFIED IN COLS. 37-42.             -
CD                                                                   -
CD  8   55-60   LABEL OF PRODUCT ISOTOPE FROM THE REACTION SPECIFIED -
CD              IN COLS. 13-18.                                      -
CD                                                                   -
CD  9   61-72   YIELD FRACTION OR ISOMERIC STATE BRANCHING FRACTION  -
CD              TO THE ISOTOPE SPECIFIED IN COLS. 55-60.             -
C                                                                    -
CN              ALL ISOTOPE LABELS APPEARING IN COLS. 7-12 OF ONE OR -
CN              MORE TYPE 09 CARDS ARE DEFINED AS "ACTIVE"; THAT IS, -
CN              THEY ARE CONSIDERED IN BURNUP/DECAY CALCULATIONS. ALL-
CN              OTHER ISOTOPES ARE "INACTIVE"; THAT IS, THEY ARE     -
CN              ASSUMED TO UNDERGO NO TRANSMUTATIONS DURING THE      -
CN              PROBLEM. AT LEAST ONE OF THE ACTIVE ISOTOPES WHICH   -
CN              IS TO BE INCLUDED IN THE CALCULATION OF CONVERSION AND -
CN              BREEDING RATIOS MUST BE DEFINED ON A TYPE 24 CARD.   -
CN                                                                   -
CN              IF COLS. 7-12 ON ONE OF THE TYPE 09 CARDS CONTAIN ANY -
CN              OF THE PRIVILEGED LABELS PUUCH1, PUUCH2, THUCH1,     -
CN              OR THUCH2, THE BURNUP CHAINS WILL BE DETERMINED      -
CN              FROM PRESTORED DATA.  IN THAT CASE, THE REMAINDER OF -
CN              THE DATA ON THAT TYPE 09 CARD WILL BE IGNORED.  IF   -
CN              TYPE 09 CARDS ARE SUPPLIED WITH NORMAL ISOTOPE DATA  -
CN              IN ADDITION TO ONE OF THE PRIVILEGED LABELS, THE DATA -
CN              WILL BE MERGED WITH THE PRESTORED CHAIN DATA.  IF    -
CN              A LABEL IN COLS. 7-12 CORRESPONDS TO ONE OF THE      -
CN              PRESTORED ISOTOPE LABELS, THE DATA ON THAT TYPE 09   -
CN              CARD WILL OVERRIDE THE PRESTORED DATA FOR THE        -
CN              CORRESPONDING REACTION TYPE.  IF IT IS DESIRED TO    -
CN              DELETE ANY OF THE PRESTORED DATA, COLS. 19-24 SHOULD -
CN              CONTAIN THE PRIVILEGED LABEL DELETE FOR A GIVEN      -
CN              ACTIVE ISOTOPE AND REACTION TYPE SPECIFIED IN COLS.  -
CN              7-12 AND 13-18 RESPECTIVELY.  IF COLS 19-24 CONTAIN  -
CN              THE PRIVILEGED LABEL DELETE, THE REST OF THE DATA ON -
CN              THAT CARD TYPE 09 WILL BE IGNORED.                   -
CN              THE LABELS USED IN THE PRESTORED CHAINS ARE: TH232,  -
CN              PA233, U-233, U-234, U-235, U-236, U-238, PU238,     -
CN              NP237, PU236, PU239, PU240, PU241, PU242, AM241,     -
CN              AM242, CM242, CM243, CM244, CM245, CM246, LFPP3,     -
CN              LFPP5, LFPP9, LFPPA, DUMP1, AND DUMP2.               -
C                                                                    -
CN              IF NO TYPE 10 CARDS ARE GIVEN, THE ISOTOPE LABELS ON -
CN              THE TYPE 09 CARDS IN COLS. 7-12 OR THE NAMES OF THE  -
CN              ISOTOPES IN THE PRESTORED BURNUP CHAINS MUST BE      -
CN              DEFINED IN THE CROSS SECTION LIBRARY ON DATA SET ISOTXS.
CN              IF ANY TYPE 10 CARDS ARE GIVEN, THE LABELS ON THE 09 -
CN              MAY BE LOCAL. THE TYPE 10 CARDS WILL RELATE THE LOCAL -
CN              LABELS TO SPECIFIC CROSS SECTION LIBRARY LABELS.     -
CN                                                                   -
CN              FOR REACTION TYPES 1-5 AND 9-10, IF ONLY ONE PRODUCT -
CN              ISOTOPE IS NAMED IN COLS. 19-24, NO YIELD FRACTION NEED-
CN              BE ENTERED (1.0 IS ASSUMED). HOWEVER, IF A YIELD     -
CN              FRACTION IS SPECIFIED FOR A SINGLE PRODUCT ISOTOPE, IT -
CN              MUST BE 1.0.  IF MORE THAN ONE PRODUCT ISOTOPE IS    -
CN              LISTED, THE YIELD FRACTIONS MUST BE GIVEN FOR EACH, AND-
CN              SUM TO 1.0 EXCEPT FOR THE CASE OF FISSION, IN WHICH  -
CN              CASE THE FRACTIONS SHOULD SUM TO THE TOTAL YIELD OF  -
CN              NUCLEI/FISSION OF THE PARENT ISOTOPE (NORMALLY 2.0). -
CN                                                                   -
CN              FOR THE RADIOACTIVE DECAY PROCESSES 6-8, NORMALLY ONLY -
CN              ONE PRODUCT ISOTOPE IS PERTINENT.  IN THESE CASES, THE -
CN              YIELD FRACTIONS NEED NOT BE 1.0, BUT THE SUM OF ALL  -
CN              OF THE YIELD FRACTIONS FOR A GIVEN ISOTOPE MUST BE   -
```

```
CN                 1.0.                                               -
CN                                                                    -
CN            IF AN ISOTOPE CONTRIBUTES TO THE TRANSMUTATION PROCESS -
CN            THEN IT IS NOT SUFFICIENT TO SPECIFY IT IN THE         -
CN            "PRODUCT ISOTOPE" FIELDS BUT IT MUST ALSO BE SPECIFIED -
CN            AT LEAST ONCE AS AN ACTIVE ISOTOPE IN FIELD 7-12 OF    -
CN            ANOTHER TYPE 09 CARD.                                   -
CN                                                                    -
CN            IF MORE THAN ONE TYPE 09 CARD IS REQUIRED TO SPECIFY   -
CN            THE PRODUCT ISOTOPES, THE LABEL OF THE ISOTOPE UNDER-  -
CN            GOING THE REACTION MUST BE REPEATED IN COLS. 7-12      -
CN            AND THE REACTION TYPE MUST BE REPEATED IN COLS. 13-18  -
CN            ON ALL SUCCEEDING TYPE 09 CARDS NEEDED TO COMPLETELY   -
CN            SPECIFY THE PRODUCT ISOTOPES.                           -
CN                                                                    -
CN            ALL ISOTOPES UNDERGOING THE (N,F) REACTION ARE         -
CN            INCLUDED IN THE CALCULATION OF BURNUP EXCEPT FOR       -
CN            THOSE BURNUP VALUES COMPUTED IN CONNECTION WITH CARD   -
CN            TYPE 06. (SEE DISCUSSION FOLLOWING CARD TYPE 06).      -
CN                                                                    -
CN            A TYPE 25 CARD MUST BE SUPPLIED FOR EACH ACTIVE ISOTOPE-
CN            WHICH HAS A REACTION TYPE OF 6, 7, OR 8.  HOWEVER,     -
CN            TYPE 25 CARDS NEED NOT BE SUPPLIED FOR ISOTOPES IN     -
CN            PRESTORED BURNUP CHAINS UNLESS IT IS DESIRED TO        -
CN            OVERRIDE THE DEFAULT DECAY CONSTANT FOR ANY OF THE     -
CN            ISOTOPES IN THE PRESTORED CHAINS OR TO DELETE SUCH     -
CN            DATA.                                                   -
CN                                                                    -
CN            NOTE THAT THE REBUS-3 CORE STORAGE REQUIREMENT GOES    -
CN            UP AS SQUARE OF NUMBER OF ACTIVE ISOTOPES.             -
CN            IN PARTICULAR, IF A PRESTORED BURNUP CHAIN IS          -
CN            SPECIFIED, THE MAXIMUM STORAGE IS REQUIRED FOR CHAIN   -
CN            THUCH2 AND PROGRESSIVELY LESSER STORAGE IS REQUIRED    -
CN            FOR CHAINS PUUCH2, THUCH1, AND PUUCH1, RESPECTIVELY.   -
C                                                                     -
C----------------------------------------------------------------------


C----------------------------------------------------------------------
CR          ACTIVE ISOTOPE LABEL EQUIVALENCE LIST (TYPE 10)          -
C                                                                     -
CL     FORMAT-----(I2,4X,11A6)                                        -
C                                                                     -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY               -
CD  =  =======  ========================================================-
CD  1  1-2      10                                                     -
CD                                                                     -
CD  2  7-12     LOCAL ISOTOPE LABEL FROM COLS. 7-12 OF TYPE 09 CARDS  -
CD              (REPEATED, IF NECESSARY, ON ADDITIONAL CARDS).        -
CD                                                                     -
CD  3  13-18    LIBRARY ISOTOPE LABEL TO BE EQUIVALENCED TO THE LOCAL -
CD              LABEL IN COLS. 7-12.                                  -
CD                                                                     -
CD  4  19-24    LIBRARY ISOTOPE LABEL TO BE EQUIVALENCED TO THE LOCAL -
CD              LABEL IN COLS. 7-12.                                  -
CD                                                                     -
CD  5  25-30    LIBRARY ISOTOPE LABEL TO BE EQUIVALENCED TO THE LOCAL -
CD              LABEL IN COLS. 7-12.                                  -
CD                                                                     -
CD  6  31-36    LIBRARY ISOTOPE LABEL TO BE EQUIVALENCED TO THE LOCAL -
CD              LABEL IN COLS. 7-12.                                  -
CD                                                                     -
CD  7  37-42    LIBRARY ISOTOPE LABEL TO BE EQUIVALENCED TO THE LOCAL -
CD              LABEL IN COLS. 7-12.                                  -
CD                                                                     -
CD  8  43-48    LIBRARY ISOTOPE LABEL TO BE EQUIVALENCED TO THE LOCAL -
CD              LABEL IN COLS. 7-12.                                  -
CD                                                                     -
CD  9  49-54    LIBRARY ISOTOPE LABEL TO BE EQUIVALENCED TO THE LOCAL -
CD              LABEL IN COLS. 7-12.                                  -
CD                                                                     -
CD 10  55-60    LIBRARY ISOTOPE LABEL TO BE EQUIVALENCED TO THE LOCAL -
```

```
CD                LABEL IN COLS. 7-12.                              -
CD                                                                 -
CD  11  61-66    LIBRARY ISOTOPE LABEL TO BE EQUIVALENCED TO THE LOCAL  -
CD                LABEL IN COLS. 7-12.                              -
CD                                                                 -
CD  12  67-72    LIBRARY ISOTOPE LABEL TO BE EQUIVALENCED TO THE LOCAL  -
CD                LABEL IN COLS. 7-12.                              -
C                                                                  -
CN                CARD TYPE 10 IS REQUIRED ONLY IF THE ISOTOPE LABELS  -
CN                IN DATA SET ISOTXS DIFFER FROM THE LABELS SPECIFIED  -
CN                ON THE TYPE 09 CARDS OR VIA A PRESTORED BURNUP CHAIN,  -
CN                OR IF DIFFERENT ISOTOPE LABELS (I.E., DIFFERENT  -
CN                MICROSCOPIC CROSS SECTIONS) ARE REQUIRED FOR THE SAME  -
CN                ISOTOPE IN DIFFERENT MATERIALS. IN SUCH CASES, EACH  -
CN                MATERIAL DEFINED ON TYPE 13 OR TYPE 14 CARDS OF DATA  -
CN                SET A.NIP3 MUST CONTAIN ALL THE LIBRARY ISOTOPE LABELS -
CN                OF THE COMPLETE CHAINS APPLICABLE TO THAT MATERIAL,  -
CN                EVEN IF THE ATOM DENSITY IS 0.0.                  -
C                                                                  -
C------------------------------------------------------------------


C------------------------------------------------------------------
CR            REPETITIVE FUEL MANAGEMENT PATH DATA (TYPE 11)       -
C                                                                  -
CL    FORMAT-----(I2,4X,A6,I6,2(I6,2A6))                           -
C                                                                  -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY           -
CD  =  =======    ==========================================================-
CD  1  1-2        11                                               -
CD                                                                 -
CD  2  7-12       PATH LABEL (REPEATED ON ADDITIONAL CARDS,        -
CD                IF NECESSARY).                                   -
CD                                                                 -
CD  3  13-18      NUMBER OF PREVIOUS BURN CYCLES                   -
CD                (NONEQUILIBRIUM PROBLEMS ONLY).                  -
CD                                                                 -
CD  4  19-24      STAGE NUMBER.                                    -
CD                                                                 -
CD  5  25-30      SECONDARY COMPOSITION LABEL (OR DISCHARGE LABEL).  -
CD                                                                 -
CD  6  31-36      PRIMARY COMPOSITION LABEL OR REGION LABEL OR FUEL  -
CD                MANAGEMENT GROUP LABEL.                          -
CD                                                                 -
CD  7  37-42      STAGE NUMBER.                                    -
CD                                                                 -
CD  8  43-48      SECONDARY COMPOSITION LABEL (OR DISCHARGE LABEL).  -
CD                                                                 -
CD  9  49-54      PRIMARY COMPOSITION LABEL OR REGION LABEL OR FUEL  -
CD                MANAGEMENT GROUP LABEL.                          -
C                                                                  -
CN                IF TYPE 35 CARDS ARE PROVIDED, ANY TYPE 11 CARDS WILL  -
CN                BE IGNORED.                                      -
CN                                                                 -
CN                EACH FUEL MANAGEMENT PATH IS DEFINED BY ITS STAGE  -
CN                NUMBERS IN ASCENDING NUMERICAL ORDER (1,2,3,...,  -
CN                NOT NECESSARILY ORDERED ON THE CARDS). THE FUEL TO BE  -
CN                MOVED IS IDENTIFIED BY THE SECONDARY COMPOSITION LABEL,-
CN                WHILE THE LOCATION OF THE FUEL IN THE REACTOR IS GIVEN  -
CN                BY THE PRIMARY COMPOSITION LABEL (WHICH IS ASSIGNED  -
CN                TO REGIONS VIA A.NIP3 TYPE 15 CARDS) OR BY A REGION  -
CN                (OR FUEL MANAGEMENT GROUP) LABEL.  SEE CARD TYPE 45  -
CN                FOR A DESCRIPTION OF THE LATTER.  FOR A GIVEN PATH,  -
CN                COLS. 31-36 AND 49-54 MUST EITHER BE ALL PRIMARY  -
CN                COMPOSITION LABELS, OR ALL REGIONS, OR ALL FUEL  -
CN                MANAGEMENT GROUP LABELS.                         -
CN                                                                 -
CN                THE SAME SECONDARY COMPOSITION MUST BE USED IN ALL  -
CN                STAGES OF A GIVEN PATH.                          -
CN                                                                 -
CN                IF PRIMARY COMPOSITION LABELS OR FUEL MANAGEMENT GROUP -
CN                LABELS ARE BEING USED TO DEFINE A PARTICULAR PATH, ALL -
```

29

```
CN          OF THESE LABELS MUST BE THE SAME OR BLANK.  THIS IS    -
CN          NECESSARY SINCE IT IS NOT POSSIBLE TO KNOW WHICH OF THE-
CN          REGIONS ASSOCIATED WITH ONE OF THE STAGES IS CONNECTED -
CN          WITH A PARTICULAR REGION IN THE NEXT STAGE IF THE FUEL  -
CN          IS BEING SHUFFLED.                                      -
CN                                                                  -
CN          IF THE PATH HAS K STAGES, THE DISCHARGE LABEL (SEE      -
CN          CARD TYPES 14 AND 15) FOR THIS PATH IS ENTERED AS THE   -
CN          SECONDARY COMPOSITION LABEL FOR THE K+1 STAGE NUMBER.   -
CN          FOR THIS CASE, THE PRIMARY COMPOSITION LABEL OR REGION  -
CN          (OR FUEL MANAGEMENT GROUP) LABEL SHOULD BE BLANK.  THE  -
CN          DISCHARGE LABEL MAY BE OMITTED IF NO FUEL IS RECYCLED   -
CN          (NO REPROCESSING PLANTS SPECIFIED).                     -
CN                                                                  -
CN          FOR EQUILIBRIUM PROBLEMS, IF A SECONDARY COMPOSITION    -
CN          RESIDES IN ONE REGION FOR SEVERAL STAGES OF A MULTI-    -
CN          STAGE PATH AND IN SOME OTHER REGION FOR OTHER STAGES,   -
CN          THE USER MUST BE CAREFUL THAT THE VOLUMES OF THE TWO    -
CN          REGIONS ARE COMPATIBLE WITH THE FRACTIONS OF THE        -
CN          COMPOSITIONS WHICH ARE BEING TRANSFERRED.  FOR EXAMPLE,-
CN          IF A SECONDARY COMPOSITION RBS1 IS LOADED INTO REGION   -
CN          BZ11 IN STAGE 1, REMAINS THERE FOR STAGE 2, AND THEN    -
CN          IS MOVED TO REGION BZ31 FOR STAGE 3 AND REMAINS IN      -
CN          REGION BZ31 FOR STAGES 4 AND 5, THE VOLUMES OF REGIONS  -
CN          BZ11 AND BZ31 SHOULD BE IN THE RATIO OF 2.0/3.0.        -
CN          THIS CAN BE SEEN SINCE FOR STAGE 3, HALF OF THE VOLUME  -
CN          OF REGION BZ11 IS BEING COMBINED WITH TWO-THIRDS OF THE-
CN          VOLUME OF REGION BZ31 AND MUST BE CONTAINED IN REGION   -
CN          BZ31.  DENOTING THE VOLUMES OF REGIONS BZ11 AND BZ31    -
CN          AS V1 AND V2 RESPECTIVELY, ALGEBRAICALLY ONE MUST       -
CN          SATISFY THE MATERIAL CONSERVATION EQUATION              -
CN               0.5(V1)+0.33333(V2)+0.33333(V2)=V2.                -
CN                                                                  -
CN          THE USE OF THE TYPE 11 CARDS MAY BE ILLUSTRATED BY THE  -
CN          FOLLOWING EXAMPLE.  CONSIDER A FOUR REGION CORE INTO    -
CN          WHICH 4 FUEL TYPES ARE LOADED AND SHUFFLED THROUGH 3    -
CN          BURN STEPS.  THE CONFIGURATION CAN BE PICTURED AS       -
CN                                                                  -
CN          BURN            MATERIAL CONTAINED IN                   -
CN          CYCLE    CORE1     CORE2     CORE3     CORE4            -
CN          -----  --------  --------  --------  --------          -
CN            1    FUEL1(0)  FUEL2(0)  FUEL3(2)  FUEL4(0)          -
CN            2    FUEL3(0)  FUEL1(1)  FUEL2(1)  FUEL4(1)          -
CN            3    FUEL4(2)  FUEL3(1)  FUEL1(2)  FUEL2(2)          -
CN                                                                  -
CN          THE NUMBERS IN PARENTHESES ARE THE NUMBER OF PREVIOUS   -
CN          BURN STEPS THE PARTICULAR FUEL HAS UNDERGONE AT THAT    -
CN          STAGE AND LOCATION IN THE SYSTEM.  THIS SEQUENCE        -
CN          WOULD BE ACCOMPLISHED BY SUPPLYING THE FOLLOWING TYPE   -
CN          11 CARDS WHICH ARE ILLUSTRATED BELOW IN FREE FORMAT     -
CN          STYLE INPUT.                                            -
CN                                                                  -
CN             11 PATH1 0 1 FUEL1 CORE1 2 FUEL1 CORE2               -
CN             11 PATH1 0 3 FUEL1 CORE3                             -
CN             11 PATH2 0 1 FUEL2 CORE2 2 FUEL2 CORE3               -
CN             11 PATH2 0 3 FUEL2 CORE4                             -
CN             11 PATH3 2 1 FUEL3 CORE3 2 FUEL3 CORE1               -
CN             11 PATH3 2 3 FUEL3 CORE2                             -
CN             11 PATH4 0 1 FUEL4 CORE4 2 FUEL4 CORE4               -
CN             11 PATH4 0 3 FUEL4 CORE1                             -
CN                                                                  -
CN          NOTE THAT OPERATIONALLY, THE CONFIGURATION ILLUSTRATED -
CN          ABOVE AS BURN CYCLE 1 WOULD BE REACHED ONLY AFTER       -
CN          PERFORMING 3 BURN CYCLES USING THE TYPE 11 CARDS LISTED-
CN          ABOVE.  THUS, COLS. 67-72 ON CARD TYPE 03 SHOULD        -
CN          CONTAIN AT LEAST 5 TO BEGIN APPROXIMATING THE REPEATING-
CN          FUEL MANAGEMENT SCHEME INDICATED ABOVE.  THE REACTOR    -
CN          FOR EACH OF THESE CYCLES WOULD BE AS INDICATED BELOW.   -
CN                                                                  -
CN          BURN            MATERIAL CONTAINED IN                   -
CN          CYCLE    CORE1     CORE2     CORE3     CORE4            -
CN          -----  --------  --------  --------  --------          -
```

30

```
CN              1      FUEL1(0)  FUEL2(0)  FUEL3(0)  FUEL4(0)      -
CN              2      FUEL3(0)  FUEL1(1)  FUEL2(1)  FUEL4(1)      -
CN              3      FUEL4(2)  FUEL3(1)  FUEL1(2)  FUEL2(2)      -
CN              4      FUEL1(0)  FUEL2(0)  FUEL3(2)  FUEL4(0)      -
CN              5      FUEL3(0)  FUEL1(1)  FUEL2(1)  FUEL4(1)      -
CN              6      FUEL4(2)  FUEL3(1)  FUEL1(2)  FUEL2(2)      -
CN              7       ...                                        -
CN                                                                -
CN           A SECONDARY COMPOSITION MUST BE DEFINED ON DATA SET  -
CN           A.NIP3 TYPE 14 CARDS, AND BE COMPRISED OF MATERIALS  -
CN           DEFINED ON DATA SET A.NIP3 TYPE 13 OR TYPE 14 CARDS. A -
CN           PRIMARY COMPOSITION MUST BE DEFINED ON DATA SET A.NIP3 -
CN           TYPE 14 CARDS IN TERMS OF A SINGLE SECONDARY         -
CN           COMPOSITION, AND BE ASSIGNED TO A REGION VIA DATA SET -
CN           A.NIP3 TYPE 15 CARDS.                                -
CN                                                                -
CN           IN STAGE 1 OF EACH PATH OF AN EQUILIBRIUM PROBLEM, AND -
CN           IN STAGE 1 OF EACH PATH HAVING COLS. 13-18 EQUAL TO 0 -
CN           OF A NON-EQUILIBRIUM PROBLEM, THE SECONDARY COMPOSITION-
CN           TO PRIMARY COMPOSITION/REGION CORRESPONDENCE MUST AGREE-
CN           WITH THAT IMPLIED FROM THE DATA SET A.NIP3 TYPE 14/15 -
CN           CARDS.                                               -
CN                                                                -
CN           NOTE THAT FOR AN EQUILIBRIUM PROBLEM, IF A REGION OR  -
CN           COMPOSITION APPEARS IN N STAGES OF A PATH, THEN AT THE -
CN           BOEC, THAT REGION WILL CONTAIN FRESH FUEL, ONCE BURNED -
CN           FUEL, TWICE BURNED FUEL,..., UP TO N-I TH BURNED FUEL -
CN           IN THE EQUILIBRIUM CONFIGURATION.                    -
CN                                                                -
CN           IN DEFINING THE MATERIALS USED TO MAKE UP SECONDARY  -
CN           COMPOSITIONS ON TYPE 13 OR TYPE 14 CARDS OF DATA SET  -
CN           A.NIP3, IF CARD TYPE 04 OF DATA SET A.BURN AND THE    -
CN           ASSOCIATED EXTERNAL CYCLE CARDS ARE PRESENT, THE ATOM -
CN           DENSITY OF ALL POSSIBLE ACTIVE ISOTOPES IN EACH      -
CN           MATERIAL MUST BE SET TO 1.0. THE ATOM DENSITIES OF   -
CN           INACTIVE ISOTOPES ARE THE ACTUAL VALUES (IN UNITS OF -
CN           ATOMS/CC * 1.0E-24).                                 -
CN                                                                -
CN           NOTE THAT FOR NON-EQUILIBRIUM PROBLEMS, IF COLS. 67-72 -
CN           ON CARD TYPE 03 IS 0, ONLY STAGE NUMBER 1 ON THE TYPE -
CN           11 CARDS IS PERTINENT.  OTHER STAGES ON THE TYPE 11  -
CN           CARDS CAN BE REACHED FOR NON-EQUILIBRIUM PROBLEMS ONLY -
CN           IF MORE THAN ONE FUEL MANAGEMENT OPERATION IS CARRIED -
CN           OUT.                                                 -
C                                                                 -
C-----------------------------------------------------------------


C-----------------------------------------------------------------
CR           REACTOR CHARGE SPECIFICATIONS (TYPE 12)             -
C                                                                 -
CL    FORMAT-----(I2,4X,A6,6X,A6,4E12.5)                          -
C                                                                 -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY           -
CD  =  =======  =========================================================-
CD  1  1-2      12                                                -
CD                                                                -
CD  2  7-12     PATH LABEL (SEE CARD TYPE 11 OR CARD TYPE 35).    -
CD                                                                -
CD  3  19-24    FUEL FABRICATION LABEL (SEE CARD TYPE 13).        -
CD                                                                -
CD  4  25-36    REFABRICATION TIME (IN DAYS).                     -
CD                                                                -
CD  5  37-48    PRELOADING STORAGE TIME (IN DAYS).                -
CD                                                                -
CD  6  49-60    INITIAL ENRICHMENT, E(M)(0) (SEE CARD TYPE 04).   -
CD                                                                -
CD  7  61-72    ENRICHMENT MODIFICATION FACTOR, DELTA(M)          -
CD              (SEE CARD TYPE 04). (DEFAULT=1.0).                -
C                                                                 -
CN              ENRICHMENT IS DEFINED AS THE VOLUME RATIO,        -
CN                                                                -
```

```
CN                    CLASS 1/(CLASS 1 + CLASS 2)                        -
C                                                                        -
C------------------------------------------------------------------------


C------------------------------------------------------------------------
CR            FUEL FABRICATION DATA (TYPE 13)                            -
C                                                                        -
CL     FORMAT-----(I2,4X,A6,6X,3(A6,E12.5))                              -
C                                                                        -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY                  -
CD  =  =======  =======================================================-
CD  1  1-2      13                                                       -
CD                                                                       -
CD  2  7-12     FUEL FABRICATION LABEL.                                  -
CD                                                                       -
CD  3  19-24    ACTIVE ISOTOPE LABEL.                                    -
CD                                                                       -
CD  4  25-36    FABRICATION DENSITY OF PURE ISOTOPE                      -
CD              (ATOMS/CC * 1.0E-24).                                    -
CD                                                                       -
CD  5  37-42    ACTIVE ISOTOPE LABEL.                                    -
CD                                                                       -
CD  6  43-54    FABRICATION DENSITY OF PURE ISOTOPE                      -
CD              (ATOMS/CC * 1.0E-24).                                    -
CD                                                                       -
CD  7  55-60    ACTIVE ISOTOPE LABEL.                                    -
CD                                                                       -
CD  8  61-72    FABRICATION DENSITY OF PURE ISOTOPE                      -
CD              (ATOMS/CC * 1.0E-24).                                    -
C                                                                        -
CN              EACH FUEL FABRICATION LABEL IDENTIFIES A SET OF          -
CN              ISOTOPIC FABRICATION DENSITIES WHICH YIELD THE DESIRED   -
CN              DENSITY OF HEAVY METAL (IN GM/CC) IN THE FABRICATED      -
CN              FUEL. THE SPECIFIC VALUE OF THE HEAVY METAL DENSITY      -
CN              WILL DEPEND ON THE PARTICULAR CHEMICAL AND PHYSICAL      -
CN              COMPOSITION OF THE FUEL CHARGES BEING FABRICATED, E.G.,-
CN              OXIDE OR CARBIDE FUEL AT SOME PERCENTAGE OF THEO-        -
CN              RETICAL DENSITY (TD) AND WEIGHT PER CENT HEAVY METAL.    -
CN                                                                       -
CN              FABRICATION DENSITY OF PURE ISOTOPE MEANS THE NUMBER     -
CN              OF ATOMS PER UNIT VOLUME WHICH WOULD BE REQUIRED IN A    -
CN              FABRICATED CHARGE TO GIVE THE DESIRED HEAVY METAL        -
CN              DENSITY ASSUMING ITS COMPOSITION IS 100 PER CENT THIS    -
CN              SINGLE ACTIVE ISOTOPE, I.E., NO ISOTOPIC DISTRIBUTION    -
CN              IN THE ELEMENT.                                          -
CN                                                                       -
CN              AS AN EXAMPLE, SUPPOSE THE FABRICATED FUEL IS TO BE      -
CN              PUO2 AT 95 PER CENT TD. ASSUMING A TD OF 11.4 GM/CC      -
CN              AND 88 WEIGHT PER CENT HEAVY METAL, THIS GIVES A         -
CN              DESIRED HEAVY METAL FABRICATION DENSITY OF 9.5304        -
CN              GM/CC. USING THE VALUE OF 0.6022054E24 FOR AVOGADRO'S    -
CN              NUMBER (SEE CARD TYPE 28) AND THE FOLLOWING ATOMIC       -
CN              WEIGHTS, THE REQUIRED ISOTOPIC FABRICATION DENSITIES     -
CN              ARE,                                                     -
CN                 ISOTOPE     ATOMIC      FABRICATION DENSITY           -
CN                             WEIGHT       OF PURE ISOTOPE              -
CN                 PU238     238.0495         2.41095E-2                 -
CN                 PU239     239.0522         2.40084E-2                 -
CN                 PU240     240.0540         2.39082E-2                 -
CN                 PU241     241.0563         2.38088E-2                 -
CN                 PU242     242.0587         2.37102E-2                 -
CN                                                                       -
CN              THE CORRESPONDING ATOM DENSITIES OF THE INACTIVE         -
CN              ISOTOPES IN THE FABRICATED FUEL ARE ENTERED DIRECTLY     -
CN              ON THE APPROPRIATE A.NIP3 TYPE 13 OR TYPE 14 CARDS.  IN-
CN              THIS EXAMPLE THE INACTIVE ISOTOPE IS OXYGEN AT AN ATOM   -
CN              DENSITY OF 4.89376E-2. ALL ACTIVE ISOTOPE LABELS MUST    -
CN              BE DEFINED ON TYPE 09 CARDS OR VIA THE PRESTORED         -
CN              BURNUP CHAINS.                                           -
CN                                                                       -
CN              SEE ALSO THE COMMENTS FOR THE TYPES 17 AND 22 CARDS      -
```

```
CN                    REGARDING THE NEED TO SPECIFY ALL OF THE ACTIVE        -
CN                    ISOTOPES ON THE TYPE 13 CARDS WHICH ARE SUPPLIED FROM  -
CN                    EXTERNAL FEEDS OR REPROCESSING PLANTS AND WHICH WILL    -
CN                    BE USED TO FABRICATE FUEL FOR ANY OF THE PATHS.         -
C                                                                             -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR              REACTOR DISCHARGE COOLING TIMES (TYPE 14)                 -
C                                                                         -
CL      FORMAT-----(I2,4X,3(A6,E12.5))                                    -
C                                                                         -
CD   #   COLUMNS            CONTENTS...IMPLICATIONS, IF ANY               -
CD   =   =======   ========================================================-
CD   1   1-2       14                                                      -
CD                                                                         -
CD   2   7-12      REACTOR DISCHARGE LABEL.                                -
CD                                                                         -
CD   3   13-24     COOLING TIME (IN DAYS).                                 -
CD                                                                         -
CD   4   25-30     REACTOR DISCHARGE LABEL.                                -
CD                                                                         -
CD   5   31-42     COOLING TIME (IN DAYS).                                 -
CD                                                                         -
CD   6   43-48     REACTOR DISCHARGE LABEL.                                -
CD                                                                         -
CD   7   49-60     COOLING TIME (IN DAYS).                                 -
C                                                                          -
CN                 THE TYPE 14 CARDS SHOULD NOT BE SUPPLIED IF THE DATA    -
CN                 MANAGEMENT IS SPECIFIED USING THE TYPE 35 CARDS.        -
CN                                                                         -
CN                 COOLING TIME MAY INCLUDE THE TIME REQUIRED FOR          -
CN                 DELIVERY FROM COOLER TO REPROCESSING PLANT              -
CN                 (SEE CARD TYPE 15).                                     -
C                                                                          -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR            REACTOR DISCHARGE DESTINATION DATA (TYPE 15)                -
C                                                                         -
CL      FORMAT-----(I2,4X,A6,6X,3(A6,E12.5))                             -
C                                                                         -
CD   #   COLUMNS            CONTENTS...IMPLICATIONS, IF ANY               -
CD   =   =======   ========================================================-
CD   1   1-2       15                                                      -
CD                                                                         -
CD   2   7-12      REACTOR DISCHARGE LABEL (REPEATED ON ADDITIONAL CARDS, -
CD                 IF NECESSARY).                                          -
CD                                                                         -
CD   3   19-24     REPROCESSING PLANT LABEL.                               -
CD                                                                         -
CD   4   25-36     FRACTION OF DISCHARGE TO BE DELIVERED TO REPROCESSING  -
CD                 PLANT.                                                  -
CD                                                                         -
CD   5   37-42     REPROCESSING PLANT LABEL.                               -
CD                                                                         -
CD   6   43-54     FRACTION OF DISCHARGE TO BE DELIVERED TO REPROCESSING  -
CD                 PLANT.                                                  -
CD                                                                         -
CD   7   55-60     REPROCESSING PLANT LABEL.                               -
CD                                                                         -
CD   8   61-72     FRACTION OF DISCHARGE TO BE DELIVERED TO REPROCESSING  -
CD                 PLANT.                                                  -
C                                                                          -
CN                 THE TYPE 15 CARDS SHOULD NOT BE SUPPLIED IF THE DATA    -
CN                 MANAGEMENT IS SPECIFIED USING THE TYPE 35 CARDS.        -
CN                                                                         -
CN                 ALL REACTOR DISCHARGE NOT DELIVERED TO SOME            -
CN                 REPROCESSING PLANT WILL BE CONSIDERED SOLD.            -
C                                                                          -
```

```
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR            REPROCESSING PLANT SPECIFICATIONS (TYPE 16)          -
C                                                                       -
CL     FORMAT-----(I2,4X,3A6,2E12.5)                                    -
C                                                                       -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY               -
CD  =  =======  ========================================================-
CD  1  1-2      16                                                      -
CD                                                                      -
CD  2  7-12     REPROCESSING PLANT LABEL.                               -
CD                                                                      -
CD  3  13-18    RECOVERY FACTOR SPECIFICATION LABEL.                    -
CD                                                                      -
CD  4  19-24    CLASS SEPARATION SPECIFICATION LABEL.                   -
CD                                                                      -
CD  5  25-36    REPROCESSING TIME (IN DAYS).                            -
CD                                                                      -
CD  6  37-48    VOLUME OF REPROCESSING PLANT INITIAL BATCH              -
CD              OUTPUT (CM**3).                                         -
C                                                                       -
CN             THE TYPE 16 CARDS SHOULD NOT BE SUPPLIED IF THE DATA    -
CN             MANAGEMENT IS SPECIFIED USING THE TYPE 35 CARDS.        -
CN                                                                     -
CN             THE CLASS SEPARATION SPECIFICATION LABEL IN COLS. 19-24-
CN             MUST ALSO APPEAR IN COLS. 7-12 ON A TYPE 18 CARD.       -
CN                                                                     -
CN             COLS. 37-48 ARE PERTINENT ONLY IF CARD TYPE 23 IS       -
CN             PROVIDED.                                               -
C                                                                      -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR            RECOVERY FACTOR DATA (TYPE 17)                         -
C                                                                       -
CL     FORMAT-----(I2,4X,A6,6X,3(A6,E12.5))                            -
C                                                                       -
CD  #  COLUMNS           CONTENTS...IMPLICATION, IF ANY                -
CD  =  =======  ========================================================-
CD  1  1-2      17                                                      -
CD                                                                      -
CD  2  7-12     RECOVERY FACTOR SPECIFICATION LABEL (REPEATED ON       -
CD              ADDITIONAL CARDS, IF NECESSARY).                        -
CD                                                                      -
CD  3  19-24    ACTIVE ISOTOPE LABEL.                                   -
CD                                                                      -
CD  4  25-36    RECOVERY FACTOR.                                        -
CD                                                                      -
CD  5  37-42    ACTIVE ISOTOPE LABEL.                                   -
CD                                                                      -
CD  6  43-54    RECOVERY FACTOR.                                        -
CD                                                                      -
CD  7  55-60    ACTIVE ISOTOPE LABEL.                                   -
CD                                                                      -
CD  8  61-72    RECOVERY FACTOR.                                        -
C                                                                       -
CN             THE TYPE 17 CARDS SHOULD NOT BE SUPPLIED IF THE DATA    -
CN             MANAGEMENT IS SPECIFIED USING THE TYPE 35 CARDS.        -
CN                                                                     -
CN             ALL ACTIVE ISOTOPES SPECIFIED FOR A PARTICULAR RECOVERY-
CN             FACTOR SPECIFICATION LABEL MUST ALSO APPEAR ON A TYPE   -
CN             13 CARD IF THE CORRESPONDING REPROCESSING PLANT         -
CN             WILL BE USED TO FABRICATE FUEL FOR SOME PATH.  THE      -
CN             PATHS ASSOCIATED WITH VARIOUS REPROCESSING PLANTS ARE   -
CN             SPECIFIED ON THE TYPE 19 AND 20 CARDS, THE REPROCESSING-
CN             PLANTS ASSOCIATED WITH THE VARIOUS RECOVERY FACTOR      -
CN             LABELS ON THE TYPE 16 CARDS, AND THE FABRICATION LABELS-
CN             ASSOCIATED WITH THE VARIOUS PATH LABELS ON THE TYPE 12  -
CN             CARDS.
```

```
CN                                                                     -
CN                ALL ACTIVE ISOTOPE LABELS MUST BE DEFINED ON TYPE 09 -
CN                CARDS OR VIA THE PRESTORED BURNUP CHAINS.             -
CN                                                                     -
CN                RECOVERY FACTOR APPLIES TO AMOUNTS LEFT AFTER DECAY   -
CN                DURING REPROCESSING TIME.                             -
C                                                                      -
C----------------------------------------------------------------------


C----------------------------------------------------------------------
CR           CLASS SEPARATION DATA (TYPE 18)                           -
C                                                                      -
CL    FORMAT-----(I2,4X,A6,6X,3(A6,E12.5))                             -
C                                                                      -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY               -
CD  =  =======  =========================================================-
CD  1  1-2      18                                                     -
CD                                                                     -
CD  2  7-12     CLASS SEPARATION SPECIFICATION LABEL (REPEATED ON      -
CD              ADDITIONAL CARDS, IF NECESSARY).                       -
CD                                                                     -
CD  3  19-24    ACTIVE ISOTOPE LABEL.                                  -
CD                                                                     -
CD  4  25-36    FRACTION OF ISOTOPE ASSIGNED TO CLASS 1 FUEL.          -
CD                                                                     -
CD  5  37-42    ACTIVE ISOTOPE LABEL.                                  -
CD                                                                     -
CD  6  43-54    FRACTION OF ISOTOPE ASSIGNED TO CLASS 1 FUEL.          -
CD                                                                     -
CD  7  55-60    ACTIVE ISOTOPE LABEL.                                  -
CD                                                                     -
CD  8  61-72    FRACTION OF ISOTOPE ASSIGNED TO CLASS 1 FUEL.          -
C                                                                      -
CN                ALL ACTIVE ISOTOPE LABELS MUST BE DEFINED ON TYPE 09 -
CN                CARDS.                                               -
CN                                                                     -
CN                CARD TYPE 18 DEFINES WHICH ISOTOPES ARE TO BE ASSIGNED -
CN                TO CLASS 1 FUEL.                                     -
CN                                                                     -
CN                CLASS 1 FUEL IS NORMALLY CONSIDERED TO BE FUEL THAT  -
CN                ADDS GREATER REACTIVITY TO THE REACTOR THAN DOES CLASS -
CN                2 FUEL. THE COMPLEMENTS OF THE FRACTIONS GIVEN IN COLS.-
CN                25-36, 43-54, AND 61-72 ARE THE FRACTIONS ASSIGNED TO -
CN                CLASS 2 FUEL.                                        -
CN                                                                     -
CN                ANY ACTIVE ISOTOPE SPECIFIED ON A TYPE 09 CARD OR IN -
CN                A PRESTORED BURNUP CHAIN THAT IS NOT GIVEN ON CARD    -
CN                TYPE 18 WILL HAVE A FRACTION 0.0 ASSIGNED TO CLASS 1  -
CN                FUEL.                                                -
C                                                                      -
C----------------------------------------------------------------------


C----------------------------------------------------------------------
CR           CLASS 1 FABRICATION SPECIFICATIONS (TYPE 19)             -
C                                                                      -
CL    FORMAT-----(I2,4X,A6,6X,2(A6,I6,E12.5))                          -
C                                                                      -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY               -
CD  =  =======  =========================================================-
CD  1  1-2      19                                                     -
CD                                                                     -
CD  2  7-12     PATH LABEL OF FABRICATION PROCESS OR SALE LABEL        -
CD              (REPEATED ON ADDITIONAL CARDS, IF NECESSARY).          -
CD                                                                     -
CD  3  19-24    REPROCESSING PLANT LABEL OR EXTERNAL FEED LABEL OF     -
CD              FUEL USED IN FABRICATION.                              -
CD                                                                     -
CD  4  25-30    PRIORITY LEVEL TO BE ASSIGNED TO ABOVE SOURCE.         -
CD                                                                     -
CD  5  31-42    DISTRIBUTION FRACTION (DEFAULT=1.0).                   -
```

35

```
CD                                                                      -
CD  6   43-48   REPROCESSING PLANT LABEL OR EXTERNAL FEED LABEL OF       -
CD              FUEL USED IN FABRICATION.                                -
CD                                                                      -
CD  7   49-54   PRIORITY LEVEL TO BE ASSIGNED TO ABOVE SOURCE.           -
CD                                                                      -
CD  8   55-66   DISTRIBUTION FRACTION (DEFAULT=1.0).                     -
C                                                                        -
CN              CARD TYPES 19 AND 20 SPECIFY THE METHOD OF SELECTING     -
CN              FUEL FOR CLASS 1 AND CLASS 2 FABRICATION.                -
CN                                                                      -
CN              THE PRIORITY LEVEL ESTABLISHES THE ORDER OF PREFERENCE   -
CN              FOR USE OF REPROCESSING PLANT OUTPUT OR EXTERNAL FEED    -
CN              FUEL IN FABRICATION OF THE VARIOUS BATCHES OF THE        -
CN              REACTOR CHARGE. THE MOST STRAIGHTFORWARD SYSTEM IS ONE   -
CN              IN WHICH ONLY ONE BATCH (SPECIFIED BY A PATH OR SALE     -
CN              LABEL) REQUIRES ATOMS FROM A GIVEN PLANT OR EXTERNAL     -
CN              FEED AT EACH PRIORITY LEVEL. IN THIS CASE ALL ATOMS      -
CN              REQUIRED FOR THE BATCH WITH PRIORITY 1 WILL BE TAKEN     -
CN              FIRST, THEN THOSE REQUIRED FOR PRIORITY 2 (IF ANY        -
CN              REMAIN), AND SO ON. PRIORITY LEVELS USED MUST BE         -
CN              CONSECUTIVE STARTING FROM 1 WITH NO OMISSIONS.           -
CN                                                                      -
CN              IF TWO OR MORE PATH OR SALE LABELS SPECIFY THE SAME      -
CN              PLANT OUTPUT OR FEED AT THE SAME PROIRITY LEVEL, THE     -
CN              AVAILABLE ATOMS WILL FIRST BE DISTRIBUTED IN PROPORTION- 
CN              TO THE DISTRIBUTION FRACTION OF EACH CHARGE. IF THE      -
CN              REQUIREMENTS OF SOME OF THESE BATCHES ARE SATISFIED      -
CN              WHILE OTHERS ARE NOT, FURTHER PROPORTIONAL               -
CN              DISTRIBUTIONS ARE MADE TO THE REMAINING BATCHES UNTIL    -
CN              EITHER ALL REQUIREMENTS ARE SATISFIED OR ALL AVAILABLE   -
CN              ATOMS ARE USED.                                          -
C                                                                        -
C----------------------------------------------------------------------

C----------------------------------------------------------------------
CR          CLASS 2 FABRICATION SPECIFICATIONS (TYPE 20)                 -
C                                                                        -
CL    FORMAT-----(I2,4X,A6,6X,2(A6,I6,E12.5))                            -
C                                                                        -
CD  #   COLUMNS          CONTENTS...IMPLICATIONS, IF ANY                 -
CD  =   ======   =======================================================-
CD  1   1-2      20                                                      -
CD                                                                      -
CD  2   7-12     PATH LABEL OF FABRICATION PROCESS OR SALE LABEL         -
CD              (REPEATED ON ADDITIONAL CARDS, IF NECESSARY).            -
CD                                                                      -
CD  3   19-24    REPROCESSING PLANT LABEL OR EXTERNAL FEED LABEL OF      -
CD              FUEL USED IN FABRICATION.                                -
CD                                                                      -
CD  4   25-30    PRIORITY LEVEL TO BE ASSIGNED TO ABOVE SOURCE.          -
CD                                                                      -
CD  5   31-42    DISTRIBUTION FRACTION (DEFAULT=1.0).                    -
CD                                                                      -
CD  6   43-48    REPROCESSING PLANT LABEL OR EXTERNAL FEED LABEL OF      -
CD              FUEL USED IN FABRICATION.                                -
CD                                                                      -
CD  7   49-54    PRIORITY LEVEL TO BE ASSIGNED TO ABOVE SOURCE.          -
CD                                                                      -
CD  8   55-66    DISTRIBUTION FRACTION (DEFAULT=1.0).                    -
C                                                                        -
CN              THE PRIORITY SYSTEM IS IDENTICAL TO THAT DESCRIBED       -
CN              FOR CLASS 1 MAKEUP ON CARD TYPE 19.                      -
C                                                                        -
C----------------------------------------------------------------------

C----------------------------------------------------------------------
CR           EXTERNAL FEED SPECIFICATIONS (TYPE 21)                      -
C                                                                        -
CL    FORMAT-----(I2,4X,2A6,E12.5)                                       -
```

```
C                                                                      -
CD  #   COLUMNS           CONTENTS...IMPLICATIONS, IF ANY              -
CD  =   =======  ========================================================-
CD  1   1-2      21                                                    -
CD                                                                     -
CD  2   7-12     EXTERNAL FEED LABEL.                                  -
CD                                                                     -
CD  3   13-18    CLASS SEPARATION SPECIFICATION LABEL.                 -
CD                                                                     -
CD  4   19-30    VOLUME OF FEED (CM**3). (DEFAULT=1.0E+30).            -
C                                                                      -
CN               THE VOLUME OF ONE OF THE EXTERNAL FEEDS MUST BE LARGE -
CN               ENOUGH TO ENSURE THAT THERE WILL ALWAYS BE ENOUGH     -
CN               FUEL TO FABRICATE ALL CHARGES. AN INFINITE VOLUME     -
CN               (I.E. 1.0E+30 CM**3) WILL BE ASSIGNED TO THE FEED     -
CN               IF COLS. 19-30 ARE BLANK.                             -
CN                                                                     -
CN               THE CLASS SEPARATION SPECIFICATION LABEL IN COLS. 13-18-
CN               MUST ALSO APPEAR IN COLS. 7-12 ON A TYPE 18 CARD.     -
C                                                                      -
C----------------------------------------------------------------------


C----------------------------------------------------------------------
CR            EXTERNAL FEED COMPOSITION (TYPE 22)                      -
C                                                                      -
CL    FORMAT-----(I2,4X,A6,6X,3(A6,E12.5))                            -
C                                                                      -
CD  #   COLUMNS           CONTENTS...IMPLICATIONS, IF ANY              -
CD  =   =======  ========================================================-
CD  1   1-2      22                                                    -
CD                                                                     -
CD  2   7-12     EXTERNAL FEED LABEL (REPEATED ON ADDITIONAL CARD,     -
CD               IF NECESSARY).                                        -
CD                                                                     -
CD  3   19-24    ACTIVE ISOTOPE LABEL.                                 -
CD                                                                     -
CD  4   25-36    ATOMIC DENSITY (ATOMS/CC * 1.0E-24).                  -
CD                                                                     -
CD  5   37-42    ACTIVE ISOTOPE LABEL.                                 -
CD                                                                     -
CD  6   43-54    ATOMIC DENSITY (ATOMS/CC * 1.0E-24).                  -
CD                                                                     -
CD  7   55-60    ACTIVE ISOTOPE LABEL.                                 -
CD                                                                     -
CD  8   61-72    ATOMIC DENSITY (ATOMS/CC * 1.0E-24).                  -
C                                                                      -
CN                                                                     -
CN                        * * *  OR  * * *                             -
CN                                                                     -
C                                                                      -
CD  1   1-2      22                                                    -
CD                                                                     -
CD  2   7-12     EXTERNAL FEED LABEL (REPEATED ON ADDITIONAL CARD,     -
CD               IF NECESSARY).                                        -
CD                                                                     -
CD  3   19-24    ACTIVE ISOTOPE LABEL.                                 -
CD                                                                     -
CD  4   25-36    RELATIVE ISOTOPIC CONCENTRATION.                      -
CD                                                                     -
CD  5   37-42    ACTIVE ISOTOPE LABEL.                                 -
CD                                                                     -
CD  6   43-54    RELATIVE ISOTOPIC CONCENTRATION.                      -
CD                                                                     -
CD  7   55-60    ACTIVE ISOTOPE LABEL.                                 -
CD                                                                     -
CD  8   61-72    RELATIVE ISOTOPIC CONCENTRATION.                      -
C                                                                      -
CN               ALL ACTIVE ISOTOPE LABELS MUST BE DEFINED ON         -
CN               TYPE 09 CARDS OR VIA A PRESTORED BURNUP CHAIN.        -
CN                                                                     -
CN               THE NUMBER OF ATOMS OF EACH ACTIVE ISOTOPE SUPPLIED   -
```

37

```
CN                  BY EACH EXTERNAL FEED IS OBTAINED FROM THE PRODUCT OF  -
CN                  THE TYPE 22 DATA AND THE CORRESPONDING VOLUME FOR THAT -
CN                  FEED SPECIFIED ON THE TYPE 21 CARDS.  IF THE VOLUME OF -
CN                  THE EXTERNAL FEED IS IMMATERIAL TO THE PROBLEM         -
CN                  SOLUTION, I.E., NOT A CONSTRAINT, ANY RELATIVE ISOTOPIC-
CN                  FRACTIONS PROPORTIONAL TO THE ACTUAL ATOMIC            -
CN                  CONCENTRATIONS MAY BE USED.                           -
CN                                                                        -
CN                  ALL ACTIVE ISOTOPES SPECIFIED FOR A PARTICULAR EXTERNAL-
CN                  FEED LABEL MUST ALSO APPEAR ON A TYPE 13 CARD IF THAT  -
CN                  EXTERNAL FEED WILL BE USED TO FABRICATE THE FUEL FOR   -
CN                  SOME PATH.  THE PATHS ASSOCIATED WITH VARIOUS EXTERNAL -
CN                  FEEDS ARE SPECIFIED ON THE TYPE 19 AND 20 CARDS, AND   -
CN                  THE FABRICATION LABELS ASSOCIATED WITH THE VARIOUS PATH-
CN                  LABELS ARE SPECIFIED ON THE TYPE 12 CARDS.            -
CN                                                                        -
C                                                                         -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR          REPROCESSING PLANT OUTPUT INITIAL COMPOSITION (TYPE 23)    -
C                                                                         -
CL     FORMAT-----(I2,4X,A6,6X,3(A6,E12.5))                              -
C                                                                         -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY                 -
CD  =  =======  =========================================================-
CD  1  1-2      23                                                       -
CD                                                                       -
CD  2  7-12     REPROCESSING PLANT LABEL (REPEATED ON ADDITIONAL         -
CD              CARDS, IF NECESSARY).                                    -
CD                                                                       -
CD  3  19-24    ACTIVE ISOTOPE LABEL.                                    -
CD                                                                       -
CD  4  25-36    ATOMIC DENSITY (ATOMS/CC * 1.0E-24).                     -
CD                                                                       -
CD  5  37-42    ACTIVE ISOTOPE LABEL.                                    -
CD                                                                       -
CD  6  43-54    ATOMIC DENSITY (ATOMS/CC * 1.0E-24).                     -
CD                                                                       -
CD  7  55-60    ACTIVE ISOTOPE LABEL.                                    -
CD                                                                       -
CD  8  61-72    ATOMIC DENSITY (ATOMS/CC * 1.0E-24).                     -
C                                                                        -
CN              THE TYPE 23 CARDS SHOULD NOT BE SUPPLIED IF THE DATA     -
CN              MANAGEMENT IS SPECIFIED USING THE TYPE 35 CARDS.         -
CN                                                                       -
CN              ALL ACTIVE ISOTOPE LABELS MUST BE DEFINED ON            -
CN              TYPE 09 CARDS OR VIA A PRESTORED BURNUP CHAIN.          -
CN                                                                       -
CN              CARD TYPE 23 IS PROVIDED ONLY IF IT IS DESIRED TO       -
CN              SPECIFY THE COMPOSITION OF THE REPROCESSING PLANT       -
CN              OUTPUT STORAGE AT THE START OF THE PROBLEM. IF CARD     -
CN              TYPE 23 IS GIVEN, COLS. 37-48 ON CARD TYPE 16 MUST      -
CN              SPECIFY THE VOLUME OF THE REPROCESSING PLANT OUTPUT.    -
C                                                                       -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR          ACTIVE ISOTOPE DESCRIPTIONS (TYPE 24)                      -
C                                                                       -
CL     FORMAT-----(I2,4X,2(A6,I6,6X,E12.5))                            -
C                                                                       -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY               -
CD  =  =======  =======================================================-
CD  1  1-2      24                                                     -
CD                                                                     -
CD  2  7-12     ACTIVE ISOTOPE LABEL.                                  -
CD                                                                     -
CD  3  13-18    FISSILE BREEDING RATIO FLAG                            -
CD                                                                     -
```

```
CD   4   25-36   ATOMIC MASS (DEFAULT OBTAINED FROM DATA SET ISOTXS).   -
CD                                                                     -
CD   5   37-42   ACTIVE ISOTOPE LABEL.                                 -
CD                                                                     -
CD   6   43-48   FISSILE BREEDING RATIO FLAG                           -
CD                                                                     -
CD   7   55-66   ATOMIC MASS (DEFAULT OBTAINED FROM DATA SET ISOTXS).  -
C                                                                      -
CN               ACTIVE ISOTOPE LABELS MUST BE DEFINED ON TYPE 09      -
CN               CARDS OR VIA A PRESTORED BURNUP CHAIN AND AT LEAST     -
CN               ONE OF THESE MUST ALSO APPEAR ON A TYPE 24 CARD ON     -
CN               WHICH A 1 APPEARS IN COLS. 13-18 OR 43-48.            -
CN               THE FISSILE BREEDING RATIO FLAG MUST BE EQUAL TO "1"   -
CN               FOR FISSILE ISOTOPES INCLUDED IN THE CALCULATION OF    -
CN               CONVERSION AND BREEDING RATIOS, AND "0" OTHERWISE.     -
CN                                                                     -
CN                         PRODUCTION OF FISSILE ATOMS                  -
CN        BREEDING RATIO = --------------------------                  -
CN                         DESTRUCTION OF FISSILE ATOMS                 -
CN                                                                     -
CN               IN REBUS-3, AVOGADRO'S NUMBER = 0.6022054E24 UNLESS    -
CN               OVERRIDDEN VIA THE DATA SET A.BURN TYPE 28 CARD DATA.  -
CN               ATOMIC MASSES SHOULD BE CONSISTENT WITH THE VALUE OF   -
CN               AVOGADRO'S NUMBER.                                    -
CN                                                                     -
CN               IF THE ATOMIC MASS AS OBTAINED FROM DATA SET ISOTXS    -
CN               HAS THE VALUE 0.0, THE MASS IS CHANGED TO 1.0.        -
CN               USERS SHOULD BE AWARE THAT ARTIFICIAL ISOTOPES SUCH AS -
CN               LUMPED FISSION PRODUCTS OR DUMMY ISOTOPES MAY HAVE     -
CN               UNREALISTIC MASSES IN DATA SET ISOTXS.  THE TYPE 24    -
CN               CARDS MAY BE USED TO PROVIDE MORE REALISTIC VALUES FOR -
CN               THE MASSES OF SUCH ISOTOPES.                          -
C                                                                      -
C----------------------------------------------------------------------


C----------------------------------------------------------------------
CR          ACTIVE ISOTOPE DECAY CONSTANTS (TYPE 25)                   -
C                                                                      -
CL    FORMAT-----(I2,4X,A6,I6,3(A6,E12.5))                            -
C                                                                      -
CD   #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY               -
CD   =  ======  ========================================================-
CD   1   1-2    25                                                     -
CD                                                                     -
CD   2   7-12   LABEL OF ACTIVE ISOTOPE UNDERGOING REACTION (REPEATED  -
CD              ON ALL CARDS THAT SPECIFY OTHER REACTIONS FOR          -
CD              THIS ISOTOPE).                                         -
CD                                                                     -
CD   3   13-18  REACTION TYPE (REPEATED ON ADDITIONAL CARDS, IF        -
CD              NECESSARY; THE SAME AS ON CARD TYPE 09).               -
CD              6...BETA-MINUS DECAY.                                  -
CD              7...BETA-PLUS DECAY.                                   -
CD              8...ALPHA DECAY.                                       -
CD                                                                     -
CD   4   19-24  LABEL OF PRODUCT ISOTOPE FROM THE REACTION SPECIFIED   -
CD              IN COLS. 13-18 OR THE PRIVILEGED LABEL DELETE.         -
CD                                                                     -
CD   5   25-36  DECAY CONSTANT (1/SEC) FOR THE ISOTOPE SPECIFIED IN    -
CD              COLS. 19-24.                                           -
CD                                                                     -
CD   6   37-42  LABEL OF PRODUCT ISOTOPE FROM THE REACTION SPECIFIED   -
CD              IN COLS. 13-18 OR THE PRIVILEGED LABEL DELETE.         -
CD                                                                     -
CD   7   43-54  DECAY CONSTANT (1/SEC) FOR THE ISOTOPE SPECIFIED IN    -
CD              COLS. 19-24.                                           -
CD                                                                     -
CD   8   55-60  LABEL OF PRODUCT ISOTOPE FROM THE REACTION SPECIFIED   -
CD              IN COLS. 13-18 OR THE PRIVILEGED LABEL DELETE.         -
CD                                                                     -
CD   9   61-72  DECAY CONSTANT (1/SEC) FOR THE ISOTOPE SPECIFIED IN    -
CD              COLS. 19-24.                                           -
```

```
C                                                                  -
CN                  A TYPE 25 CARD IS REQUIRED FOR EACH ISOTOPE WHICH HAS  -
CN                  A REACTION TYPE 6-8 SPECIFIED IN COLS. 13-18 ON A TYPE -
CN                  09 CARD.  TYPE 25 CARDS NEED NOT BE SUPPLIED FOR       -
CN                  ISOTOPES IN PRESTORED BURNUP CHAINS (SEE CARD TYPE 09) -
CN                  UNLESS IT IS DESIRED TO OVERRIDE THE DEFAULT           -
CN                  DECAY CONSTANTS FOR ANY OF THE ISOTOPES IN THE         -
CN                  PRESTORED CHAINS.  IF A TYPE 09 CARD WAS SUPPLIED WITH -
CN                  THE PRIVILEGED LABEL DELETE IN COLS. 19-24 FOR AN      -
CN                  ACTIVE ISOTOPE HAVING A REACTION TYPE 6, 7, OR 8, A    -
CN                  CORRESPONDING TYPE 25 CARD MUST BE SUPPLIED            -
CN                  WHICH SIMILARLY HAS DELETE IN COLS. 19-24 FOR THE      -
CN                  SAME ACTIVE ISOTOPE AND REACTION TYPE IN COLS. 7-12    -
CN                  AND 13-18 RESPECTIVELY.  IF A TYPE 25 CARD HAS THE     -
CN                  PRIVILEGED LABEL DELETE IN COLS 19-24, THE REST OF THE -
CN                  DATA ON THAT TYPE 25 CARD WILL BE IGNORED.             -
C                                                                  -
C-----------------------------------------------------------------


C-----------------------------------------------------------------
CR          ISOTOPES HAVING BURNUP DEPENDENT CROSS SECTIONS (TYPE 26)  -
C                                                                  -
CL    FORMAT-----(I2,4X,A6,10A6)                                   -
C                                                                  -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY            -
CD  = =======  =======================================================-
CD  1  1-2     26                                                  -
CD                                                                 -
CD  2  7-12    LABEL OF REFERENCE BASE ISOTOPE.                    -
CD                                                                 -
CD  3  13-18   LABEL OF THE ISOTOPE WHOSE CROSS SECTIONS ARE TO BE -
CD             VARIED AS A FUNCTION OF THE ATOMIC DENSITY OF THE   -
CD             REFERENCE BASE ISOTOPE SPECIFIED IN COLS. 7-12.     -
CD                                                                 -
CD  4  19-24   LABEL OF THE ISOTOPE WHOSE CROSS SECTIONS ARE TO BE -
CD             VARIED AS A FUNCTION OF THE ATOMIC DENSITY OF THE   -
CD             REFERENCE BASE ISOTOPE SPECIFIED IN COLS. 7-12.     -
CD                                                                 -
CD  5  25-30   LABEL OF THE ISOTOPE WHOSE CROSS SECTIONS ARE TO BE -
CD             VARIED AS A FUNCTION OF THE ATOMIC DENSITY OF THE   -
CD             REFERENCE BASE ISOTOPE SPECIFIED IN COLS. 7-12.     -
CD                                                                 -
CD  6  31-36   LABEL OF THE ISOTOPE WHOSE CROSS SECTIONS ARE TO BE -
CD             VARIED AS A FUNCTION OF THE ATOMIC DENSITY OF THE   -
CD             REFERENCE BASE ISOTOPE SPECIFIED IN COLS. 7-12.     -
CD                                                                 -
CD  7  37-42   LABEL OF THE ISOTOPE WHOSE CROSS SECTIONS ARE TO BE -
CD             VARIED AS A FUNCTION OF THE ATOMIC DENSITY OF THE   -
CD             REFERENCE BASE ISOTOPE SPECIFIED IN COLS. 7-12.     -
CD                                                                 -
CD  8  43-48   LABEL OF THE ISOTOPE WHOSE CROSS SECTIONS ARE TO BE -
CD             VARIED AS A FUNCTION OF THE ATOMIC DENSITY OF THE   -
CD             REFERENCE BASE ISOTOPE SPECIFIED IN COLS. 7-12.     -
CD                                                                 -
CD  9  49-54   LABEL OF THE ISOTOPE WHOSE CROSS SECTIONS ARE TO BE -
CD             VARIED AS A FUNCTION OF THE ATOMIC DENSITY OF THE   -
CD             REFERENCE BASE ISOTOPE SPECIFIED IN COLS. 7-12.     -
CD                                                                 -
CD 10  55-60   LABEL OF THE ISOTOPE WHOSE CROSS SECTIONS ARE TO BE -
CD             VARIED AS A FUNCTION OF THE ATOMIC DENSITY OF THE   -
CD             REFERENCE BASE ISOTOPE SPECIFIED IN COLS. 7-12.     -
CD                                                                 -
CD 11  61-66   LABEL OF THE ISOTOPE WHOSE CROSS SECTIONS ARE TO BE -
CD             VARIED AS A FUNCTION OF THE ATOMIC DENSITY OF THE   -
CD             REFERENCE BASE ISOTOPE SPECIFIED IN COLS. 7-12.     -
CD                                                                 -
CD 12  67-72   LABEL OF THE ISOTOPE WHOSE CROSS SECTIONS ARE TO BE -
CD             VARIED AS A FUNCTION OF THE ATOMIC DENSITY OF THE   -
CD             REFERENCE BASE ISOTOPE SPECIFIED IN COLS. 7-12.     -
C                                                                  -
CN                  TYPE 26 CARDS ARE TO BE PROVIDED ONLY IF IT IS DESIRED -
```

```
CN                    TO USE BURNUP-DEPENDENT CROSS SECTIONS IN A PROBLEM.   -
CN                                                                           -
CN                    EACH ISOTOPE APPEARING ON A TYPE 26 CARD MUST ALSO BE  -
CN                    SPECIFIED ON A TYPE 10 OR 09 CARD AND ON A TYPE 13      -
CN                    AND/OR 14 CARD OF DATA SET A.NIP3.  THAT IS, THE        -
CN                    ISOTOPES SPECIFIED ON THE TYPE 26 CARDS ARE THOSE WHICH-
CN                    ARE INCLUDED IN THE REBUS-3 CALCULATION.               -
CN                                                                           -
CN                    NORMALLY, DIFFERENT REFERENCE BASE ISOTOPES WOULD       -
CN                    BE SPECIFIED FOR DIFFERENT REGIONS OF THE REACTOR       -
CN                    BEING CALCULATED.  THUS, E.G., U235I MIGHT BE USED FOR -
CN                    THE BASE ISOTOPE IN AN INNER CORE, U235O IN AN OUTER    -
CN                    CORE REGION, AND PU239B IN A RADIAL BLANKET WHICH WAS   -
CN                    INITIALLY FUELED WITH DEPLETED URANIUM.  IN THE FIRST   -
CN                    CASE, THE U235I AND U235O DENSITIES WOULD DECREASE      -
CN                    WITH TIME WHEREAS IN THE LATTER CASE, THE PU239B        -
CN                    DENSITY WOULD INCREASE IN CONCENTRATION WITH TIME.      -
CN                                                                           -
CN                    ISOTOPES WHICH ARE REPEATED IN COLS. 13-72 ON A GIVEN  -
CN                    TYPE 26 CARD WILL BE IGNORED AS WILL ISOTOPES WHICH ARE-
CN                    REPEATED ON SUBSEQUENT TYPE 26 CARDS.  THUS, IF ONE     -
CN                    SUPPLIED                                               -
CN                                                                           -
CN                    26 U25I1 U25I1 U28I1 U25I1                              -
CN                    26 U28I1 U25I1 U28I1                                    -
CN                                                                           -
CN                    THE RESULT WOULD BE THE SAME AS IF ONE HAD SUPPLIED    -
CN                                                                           -
CN                    26 U25I1 U25I1 U28I1                                    -
C                                                                            -
C---------------------------------------------------------------------------


C---------------------------------------------------------------------------
CR              END-OF-CYCLE KEFF SEARCH DATA (TYPE 27)                      -
C                                                                            -
CL     FORMAT-----(I2,10X,3E12.5)                                           -
C                                                                            -
CD  #  COLUMNS              CONTENTS...IMPLICATIONS, IF ANY                  -
CD  =  =======  ==========================================================-
CD  1  1-2      27                                                          -
CD                                                                          -
CD  2  13-24    DESIRED END-OF-CYCLE KEFF, KEFF(EOC). (DEFAULT=1.0)          -
CD                                                                          -
CD  3  25-36    CONVERGENCE CRITERION, EPSD: RELATIVE ERROR ALLOWABLE       -
CD              IN KEFF(EOC).  FOR CONVERGENCE OF END-OF-CYCLE              -
CD              KEFF SEARCH.  (DEFAULT=0.001)                              -
CD                                                                          -
CD  4  37-48    SECOND BURN CYCLE TIME GUESS FOR END-OF-CYCLE KEFF          -
CD              SEARCH.  (DEFAULT=INITIAL BURN CYCLE TIME GUESS FROM        -
CD              COLS. 37-48 OF CARD TYPE 03 PLUS 10 PER CENT)              -
C                                                                          -
CN                    IF A TYPE 27 CARD IS INCLUDED IN THE INPUT DATA, THE  -
CN                    REACTOR BURN CYCLE TIME WILL BE ADJUSTED TO ACHIEVE   -
CN                    THE SPECIFIED END-OF-CYCLE KEFF.  CARD TYPE 04 (AND   -
CN                    ASSOCIATED EXTERNAL CYCLE CARDS) MUST BE PRESENT IN   -
CN                    THE INPUT DATA IF AN END-OF-CYCLE KEFF SEARCH IS TO   -
CN                    BE DONE.  HOWEVER, AN ENRICHMENT SEARCH AND/OR A      -
CN                    BURNUP SEARCH CANNOT BE PERFORMED SIMULTANEOUSLY WITH -
CN                    AN KEFF(EOC) SEARCH.  THEREFORE, IF A TYPE 27 CARD IS -
CN                    PRESENT IN THE INPUT DATA, THE ENRICHMENT AND BURNUP  -
CN                    CONVERGENCE CRITERIA (EPSF AND EPSG FROM CARD TYPES 04-
CN                    AND 03 RESPECTIVELY) MUST BE SPECIFIED AS 1.0 OR      -
CN                    LARGER.                                              -
CN                                                                          -
CN                    USERS SHOULD BE CAREFUL TO SPECIFY THE DESIRED CHARGE -
CN                    SEARCH PARAMETER ON THE TYPE 04 CARD IN COLS. 49-60.  -
CN                                                                          -
CN                    NOTE THAT PROBLEMS INVOLVING MEDIUM-TO-HIGH DISCHARGE -
CN                    BURNUP (GREATER THAN ABOUT 20 ATOM PER CENT) WILL     -
CN                    REQUIRE AT LEAST 2 CYCLIC MODE ITERATIONS IN ORDER TO -
CN                    INSURE CONVERGED EOC EIGENVALUES. (SEE CARD TYPE 02). -
```

41

```
C                                                                             -
C-----------------------------------------------------------------------------

C-----------------------------------------------------------------------------
CR             AVOGADRO'S NUMBER (TYPE 28)                                     -
C                                                                             -
CL     FORMAT-----(I2,10X,E12.5)                                              -
C                                                                             -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY                      -
CD  =  ======  =======================================================-
CD  1  1-2      28                                                            -
CD                                                                           -
CD  2  13-24   AVAGADRO'S NUMBER (DEFAULT=0.6022054 E+24)                     -
C                                                                             -
C-----------------------------------------------------------------------------


C-----------------------------------------------------------------------------
CR             SUMMARY EDITS AREA SPECIFICATIONS (TYPE 29)                     -
C                                                                             -
CL     FORMAT-----(I2,4X,10A6)                                               -
C                                                                             -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY                      -
CD  =  ======  =======================================================-
CD  1  1-2      29                                                            -
CD                                                                           -
CD  2  7-12    AREA LABEL CORRESPONDING TO THE INNER CORE.                    -
CD             (DEFAULT=ICORE)                                                -
CD                                                                           -
CD  3  13-18   AREA LABEL CORRESPONDING TO THE MIDDLE CORE.                   -
CD             (DEFAULT=MCORE)                                                -
CD                                                                           -
CD  4  19-24   AREA LABEL CORRESPONDING TO THE OUTER CORE.                    -
CD             (DEFAULT=OCORE)                                                -
CD                                                                           -
CD  5  25-30   AREA LABEL CORRESPONDING TO THE INNER BLANKET.                 -
CD             (DEFAULT=IBLKT)                                                -
CD                                                                           -
CD  6  31-36   AREA LABEL CORRESPONDING TO THE MIDDLE BLANKET.                -
CD             (DEFAULT=MBLKT)                                                -
CD                                                                           -
CD  7  37-42   AREA LABEL CORRESPONDING TO THE OUTER BLANKET.                 -
CD             (DEFAULT=OBLKT)                                                -
CD                                                                           -
CD  8  43-48   AREA LABEL CORRESPONDING TO THE RADIAL BLANKET.                -
CD             (DEFAULT=RBLKT)                                                -
CD                                                                           -
CD  9  49-54   AREA LABEL CORRESPONDING TO THE AXIAL BLANKET.                 -
CD             (DEFAULT=ABLKT)                                                -
CD                                                                           -
CD 10  55-60   AREA LABEL CORRESPONDING TO THE CONTROL RODS.                  -
CD             (DEFAULT=CONTRL)                                               -
CD                                                                           -
CD 11  61-66   AREA LABEL CORRESPONDING TO THE OUTER RADIAL BLANKET.          -
CD             (DEFAULT=ORBLKT)                                               -
C                                                                             -
CN             TYPE 29 CARD DATA INDICATE THE CORRESPONDENCE BETWEEN          -
CN             THE AREA LABELS ON THE DATA SET A.NIP3 TYPE 07 CARDS           -
CN             AND THE VARIOUS PORTIONS OF THE REACTOR.  MASS BALANCE         -
CN             WILL BE PROVIDED FOR THE INNER CORE+MIDDLE CORE+OUTER          -
CN             CORE, INNER BLANKET+MIDDLE BLANKET+OUTER BLANKET,              -
CN             RADIAL BLANKET, AXIAL BLANKET, AND OUTER RADIAL                -
CN             BLANKET.                                                       -
C                                                                             -
C-----------------------------------------------------------------------------


C-----------------------------------------------------------------------------
CR             SUMMARY MASS BALANCE ISOTOPE SPECIFICATIONS (TYPE 30)          -
C                                                                             -
CL     FORMAT-----(I2,4X,5(I6,A6))                                           -
```

```
C                                                                     -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY               -
CD  =  =======  ========================================================-
CD  1  1-2      30                                                    -
CD                                                                    -
CD  2  7-12     ACTIVE ISOTOPE NUMBER.                                -
CD                                                                    -
CD  3  13-18    ACTIVE ISOTOPE LABEL.                                 -
CD                                                                    -
CD  4  19-24    ACTIVE ISOTOPE NUMBER.                                -
CD                                                                    -
CD  5  25-30    ACTIVE ISOTOPE LABEL.                                 -
CD                                                                    -
CD  6  31-36    ACTIVE ISOTOPE NUMBER.                                -
CD                                                                    -
CD  7  37-42    ACTIVE ISOTOPE LABEL.                                 -
CD                                                                    -
CD  8  43-48    ACTIVE ISOTOPE NUMBER.                                -
CD                                                                    -
CD  9  49-54    ACTIVE ISOTOPE LABEL.                                 -
CD                                                                    -
CD 10  55-60    ACTIVE ISOTOPE NUMBER.                                -
CD                                                                    -
CD 11  60-66    ACTIVE ISOTOPE LABEL.                                 -
C                                                                     -
CN              NOTE THAT THE ISOTOPE LABELS MAY CORRESPOND TO EITHER -
CN              THE FIVE LEFTMOST CHARACTERS OF THE ENDF/B ABSOLUTE   -
CN              ISOTOPE LABEL OR TO THE LABELS ON THE TYPE 09 CARDS.  -
CN                                                                    -
CN              TYPE 30 CARD DATA INDICATE THE ABSOLUTE LABELS FOR THE -
CN              22 ACTIVE ISOTOPES WHICH ARE INCLUDED IN THE SUMMARY  -
CN              MASS BALANCE EDITS.  THE DEFAULT LABELS CORRESPONDING -
CN              TO THE 22 ISOTOPES ARE AS LISTED BELOW.               -
CN                      1...TH232                                     -
CN                      2...PA233                                     -
CN                      3...U-233                                     -
CN                      4...U-234                                     -
CN                      5...U-235                                     -
CN                      6...U-236                                     -
CN                      7...U-238                                     -
CN                      8...NP237                                     -
CN                      9...PU236                                     -
CN                     10...PU238                                     -
CN                     11...PU239                                     -
CN                     12...PU240                                     -
CN                     13...PU241                                     -
CN                     14...PU242                                     -
CN                     15...AM241                                     -
CN                     16...AM242                                     -
CN                     17...AM243                                     -
CN                     18...CM242                                     -
CN                     19...CM243                                     -
CN                     20...CM244                                     -
CN                     21...CM245                                     -
CN                     22...CM246                                     -
CN                                                                    -
CN              IF THE ISOTXS DATA SET BEING USED HAD U235 AS THE     -
CN              ABSOLUTE ISOTOPE LABEL FOR URANIUM 235 ISOTOPES IN THE -
CN              SET, THE USER WOULD HAVE TO SUPPLY A TYPE 30 CARD WITH -
CN                   30   5   U235                                    -
CN              (IN FREE FORMAT INPUT) TO ASSURE THAT THE URANIUM 235 -
CN              MASSES WERE INCLUDED IN THE SUMMARY EDITS.            -
CN                                                                    -
CN              NOTE THAT IF SPECIAL ISOTOPES ARE TREATED AS ACTIVE   -
CN              ISOTOPES, THEY CAN BE INCLUDED IN PLACE OF ONE OF THE -
CN              ABOVE 22 STANDARD ISOTOPES.  FOR EXAMPLE, IF BORON 10 -
CN              WERE AN ACTIVE ISOTOPE AND THE PROBLEM CONTAINED NO   -
CN              THORIUM, ONE MIGHT INPUT A TYPE 30 CARD AS            -
CN                   30   1   B-10                                    -
CN              IN WHICH CASE THE MASS EDIT FOR BORON 10 WILL APPEAR  -
CN              IN THE POSITION WHERE THORIUM NORMALLY APPEARS.       -
CN              HOWEVER, IN THIS CASE, B-10 WOULD BE THEN BE INCLUDED -
```

```
CN                 IN THE TOTAL HEAVY METAL EDIT.                         -
C                                                                        -
C------------------------------------------------------------------------


C------------------------------------------------------------------------
CR            SUMMARY NEUTRON BALANCE ISOTOPE SPECIFICATIONS (TYPE 31)   -
C                                                                        -
CL     FORMAT-----(I2,4X,I6,10A6)                                        -
C                                                                        -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY                 -
CD  =  =======  =========================================================-
CD  1  1-2      31                                                       -
CD                                                                       -
CD  2  7-12     ISOTOPE CLASSIFICATION.                                  -
CD                                                                       -
CD  3  13-18    ISOTOPE ABSOLUTE OR UNIQUE LABEL                         -
CD                                                                       -
CD  4  19-24    ISOTOPE ABSOLUTE OR UNIQUE LABEL                         -
CD                                                                       -
CD  5  25-30    ISOTOPE ABSOLUTE OR UNIQUE LABEL                         -
CD                                                                       -
CD  6  31-36    ISOTOPE ABSOLUTE OR UNIQUE LABEL.                        -
CD                                                                       -
CD  7  37-42    ISOTOPE ABSOLUTE OR UNIQUE LABEL                         -
CD                                                                       -
CD  8  43-48    ISOTOPE ABSOLUTE OR UNIQUE LABEL.                        -
CD                                                                       -
CD  9  49-54    ISOTOPE ABSOLUTE OR UNIQUE LABEL                         -
CD                                                                       -
CD 10  55-60    ISOTOPE ABSOLUTE OR UNIQUE LABEL.                        -
CD                                                                       -
CD 11  61-66    ISOTOPE ABSOLUTE OR UNIQUE LABEL                         -
CD                                                                       -
CD 12  67-72    ISOTOPE ABSOLUTE OR UNIQUE LABEL                         -
C                                                                        -
CN                 IF NO TYPE 31 CARDS ARE SUPPLIED, THE DATA SUPPLIED   -
CN                 ON THE TYPE 04 CARDS OF DATA SET A.SUMMAR WILL BE USED -
CN                 IF PROVIDED.                                          -
CN                                                                       -
CN                 THE TYPE 31 CARDS INDICATE THE CLASSIFICATION OF THE  -
CN                 ISOTOPES IN THE PROBLEM.  COLS. 7-12 CORRESPOND TO    -
CN                 THE FOLLOWING TABLE.                                  -
CN                                                                       -
CN                         ISOTOPE CLASSIFICATION                        -
CN                             1...FISSILE                               -
CN                             2...FERTILE                               -
CN                             3...OTHER ACTINIDE                        -
CN                             4...FISSION PRODUCT                       -
CN                             5...STRUCTURE                             -
CN                             6...COOLANT                               -
CN                             7...CONTROL                               -
CN                             8...UNDEFINED                             -
CN                             9...SPECIAL                               -
CN                                                                       -
CN                 NOTE THAT THE ISOTOPE ABSOLUTE LABELS CORRESPOND TO   -
CN                 THE FIVE LEFTMOST CHARACTERS OF THE ENDF/B ABSOLUTE   -
CN                 ISOTOPE LABEL.                                        -
CN                                                                       -
CN                 IF AN ISOTOPE LABEL IN COLS. 13-72 CORRESPONDS TO AN  -
CN                 ENDF/B ABSOLUTE ISOTOPE LABEL, THEN ALL ISOTOPES IN   -
CN                 THE PROBLEM HAVING THAT ABSOLUTE LABEL WILL BE GIVEN  -
CN                 THE CLASSIFICATION SPECIFIED IN COLS. 7-12.  IF AN    -
CN                 ISOTOPE LABEL CORRESPONDS TO A UNIQUE ISOTOPE LABEL,  -
CN                 THEN ONLY THAT UNIQUE ISOTOPE IN THE PROBLEM WILL     -
CN                 BE GIVEN THE SPECIFIED CLASSIFICATION AND ALL OTHER   -
CN                 ISOTOPES HAVING THE SAME ABSOLUTE LABEL AS THAT OF THE -
CN                 SPECIFIED UNIQUE ISOTOPE LABEL WILL BE GIVEN DEFAULT  -
CN                 CLASSIFICATIONS.  ISOTOPES WHICH ARE NOT SPECIFIED    -
CN                 ON THE TYPE 31 CARDS WILL BE GIVEN DEFAULT            -
CN                 CLASSIFICATIONS ACCORDING TO THEIR ABSOLUTE LABELS.   -
C                                                                        -
```

```
C----------------------------------------------------------------------

C----------------------------------------------------------------------
CR             SUMMARY MASS FLOW SPECIFICATIONS 1 (TYPE 32)          -
C                                                                    -
CL      FORMAT-----(I2,4X,4E12.6,2I6)                                -
C                                                                    -
CD   #   COLUMNS          CONTENTS...IMPLICATIONS, IF ANY            -
CD   =   =======   ========================================================-
CD   1   1-2       32                                                -
CD                                                                   -
CD   2   7-18      EMW, MEGAWATTS ELECTRIC. (DEFAULT=1000.0)         -
CD                                                                   -
CD   3   19-30     THMW, MEGAWATTS THERMAL. (DEFAULT=2740.0)         -
CD                                                                   -
CD   4   31-42     CF, CAPACITY FACTOR IN PER CENT. (DEFAULT=0.75)   -
CD                                                                   -
CD   5   43-54     FPD, CYCLE LENGTH IN FULL POWER DAYS. (DEFAULT=273.75) -
CD                                                                   -
CD   6   55-60     NPOW, RATIO OF ACTUAL POWER TO POWER USED FOR MASS -
CD                  FLOW CALCULATION. (DEFAULT=2)                    -
CD                                                                   -
CD   7   61-66     NZONE, NUMBER OF REACTOR ZONES.  NZONE=3 IF THERE ARE -
CD                  NO INTERNAL BLANKETS, OR 4 IF THERE ARE INTERNAL  -
CD                  BLANKETS. (DEFAULT=3)                            -
C                                                                    -
CN                  NPOW IN COLS. 55-60 IS USED TO ACCOUNT FOR THE SYMMETRY-
CN                  INVOLVED IN THE NEUTRONICS CALCULATION.  THUS, E.G.,  -
CN                  IF ONLY HALF OF THE REACTOR IS BEING CALCULATED, THE  -
CN                  HEAVY METAL INVENTORY MUST BE MULTIPLIED BY 2 SINCE   -
CN                  THE THMW SPECIFIED FOR THE NEUTRONICS CALCULATION     -
CN                  CORRESPONDS TO THE FULL POWER FOR THE COMPLETE REACTOR.-
CN                                                                   -
CN                  IF THE TYPE 32 CARD IS SUPPLIED, BLANK FIELDS WILL   -
CN                  CORRESPOND TO 0.0 OR 0 ACCORDING TO THE TYPE OF DATA  -
CN                  TO BE SUPPLIED.  THE DEFAULT VALUES WILL APPLY ONLY IF -
CN                  THE TYPE 32 CARD IS NOT PROVIDED.                -
C                                                                    -
C----------------------------------------------------------------------


C----------------------------------------------------------------------
CR             SUMMARY MASS FLOW SPECIFICATIONS 2 (TYPE 33)          -
C                                                                    -
CL      FORMAT-----(I2,4X,3E12.6,I6,A6)                              -
C                                                                    -
CD   #   COLUMNS          CONTENTS...IMPLICATIONS, IF ANY            -
CD   =   =======   ========================================================-
CD   1   1-2       33                                                -
CD                                                                   -
CD   2   7-18      EXT, EXTERNAL CYCLE TIME IN CALENDAR YEARS.       -
CD                  (DEFAULT=1.0)                                    -
CD                                                                   -
CD   3   19-30     FLOSS, FRACTIONAL LOSS IN REPROCESSING. (DEFAULT=0.02) -
CD                                                                   -
CD   4   31-42     EU235, U-235 FRACTION IN FERTILE URANIUM.         -
CD                  (DEFAULT=0.002)                                  -
CD                                                                   -
CD   5   43-48     NFIS, FISSILE DEFINITION FLAG.  0...U-235 NOT     -
CD                  INCLUDED IN FISSILE DEFINITION, 1...U-235 INCLUDED -
CD                  IN FISSILE DEFINITION.  (DEFAULT=1)              -
CD                                                                   -
CD   6   49-54     CFEED, LABEL OF EXTERNAL FEED SOURCE FOR THE CORE -
C                                                                    -
CN                  IF THE TYPE 33 CARD IS SUPPLIED, BLANK FIELDS WILL   -
CN                  CORRESPOND TO 0.0 OR 0 ACCORDING TO THE TYPE OF DATA  -
CN                  TO BE SUPPLIED.  THE DEFAULT VALUES WILL APPLY ONLY IF -
CN                  THE TYPE 33 CARD IS NOT PROVIDED.                -
C                                                                    -
C----------------------------------------------------------------------
```

```
C-----------------------------------------------------------------------
CR          SUMMARY MASS FLOW SPECIFICATIONS 3 (TYPE 34)         -
C                                                                -
CL     FORMAT-----(I2,4X,7I6)                                    -
C                                                                -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY         -
CD  =  ======  ==========================================================-
CD  1  1-2     34                                                -
CD                                                               -
CD  2  7-12    NC, CORE RESIDENCE IN NUMBER OF CYCLES. (DEFAULT=1)  -
CD                                                               -
CD  3  13-18   NRB, RADIAL BLANKET RESIDENCE IN NUMBER OF CYCLES.  -
CD                 (DEFAULT=5)                                   -
CD                                                               -
CD  4  19-24   NIB, INNER BLANKET RESIDENCE IN NUMBER OF CYCLES.   -
CD                 (DEFAULT=0)                                   -
CD                                                               -
CD  5  25-30   NFERAB, FERTILE MATERIAL TYPE IN THE AXIAL BLANKET.  -
CD                 0...URANIUM, 1...THORIUM. (DEFAULT=0)         -
CD                                                               -
CD  6  31-36   NFERRB, FERTILE MATERIAL TYPE IN THE RADIAL BLANKET.  -
CD                 0...URANIUM, 1...THORIUM. (DEFAULT=0)         -
CD                                                               -
CD  7  37-42   NFERIB, FERTILE MATERIAL TYPE IN THE INNER BLANKET.  -
CD                 0...URANIUM, 1...THORIUM. (DEFAULT=0)         -
CD                                                               -
CD  8  43-48   NORB, OUTER RADIAL BLANKET RESIDENCE IN NUMBER OF   -
CD                 CYCLES. (DEFAULT=0)                           -
C                                                                -
CN             IF AN OUTER RADIAL BLANKET IS INCLUDED, NFERRB    -
CN             SPECIFIED IN COLS. 31-36 WILL APPLY TO BOTH THE INNER  -
CN             AND OUTER PORTIONS OF THE RADIAL BLANKET ALTHOUGH EACH -
CN             MAY HAVE A DISTINCT RESIDENCE TIME AS SPECIFIED BY NRB -
CN             IN COLS. 13-18 AND NORB IN COLS. 43-48.          -
CN                                                               -
CN             IF THE TYPE 34 CARD IS SUPPLIED, BLANK FIELDS WILL  -
CN             CORRESPOND TO 0.  THE DEFAULT VALUES WILL APPLY ONLY  -
CN             IF THE TYPE 34 CARD IS NOT PROVIDED.             -
C                                                                -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR          GENERAL FUEL MANAGEMENT SPECIFICATIONS (TYPE 35)    -
C                                                                -
CL     FORMAT-----(I2,4X,A6,A6,3(A6,2I6))                        -
C                                                                -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY         -
CD  =  ======  ==========================================================-
CD  1  1-2     35                                                -
CD                                                               -
CD  2  7-12    PATH LABEL (REPEATED ON ADDITIONAL CARDS, IF     -
CD             NECESSARY).                                       -
CD                                                               -
CD  3  13-18   PRIMARY COMPOSITION (ZONE) OR SECONDARY COMPOSITION  -
CD             (SUB-ZONE) LABEL                                  -
CD                                                               -
CD  4  19-24   REGION LABEL OR FUEL MANAGEMENT GROUP LABEL OR    -
CD             PRIMARY COMPOSITION (ZONE) LABEL.                 -
CD                                                               -
CD  5  25-30   BEGINNING STAGE NUMBER FOR WHICH THE COMPOSITION  -
CD             SPECIFIED IN COLS. 13-18 RESIDES IN THE REGION OR ZONE -
CD             SPECIFIED IN COLS. 19-24.                         -
CD                                                               -
CD  6  31-36   ENDING STAGE NUMBER FOR WHICH THE COMPOSITION     -
CD             SPECIFIED IN COLS. 13-18 RESIDES IN THE REGION OR ZONE -
CD             SPECIFIED IN COLS. 19-24.                         -
CD                                                               -
CD  7  37-42   REGION LABEL OR FUEL MANAGEMENT GROUP LABEL OR    -
CD             PRIMARY COMPOSITION (ZONE) LABEL.                 -
CD                                                               -
CD  8  43-48   BEGINNING STAGE NUMBER FOR WHICH THE COMPOSITION  -
```

46

```
CD                    SPECIFIED IN COLS. 13-18 RESIDES IN THE REGION OR ZONE -
CD                    SPECIFIED IN COLS. 37-42.
CD                                                                          -
CD   9  49-54         ENDING STAGE NUMBER FOR WHICH THE COMPOSITION         -
CD                    SPECIFIED IN COLS. 13-18 RESIDES IN THE REGION OR ZONE -
CD                    SPECIFIED IN COLS. 37-42.                             -
CD                                                                          -
CD  10  55-60         REGION LABEL OR FUEL MANAGEMENT GROUP LABEL OR        -
CD                    PRIMARY COMPOSITION (ZONE) LABEL.                     -
CD                                                                          -
CD  11  61-66         BEGINNING STAGE NUMBER FOR WHICH THE COMPOSITION      -
CD                    SPECIFIED IN COLS. 13-18 RESIDES IN THE REGION OR ZONE -
CD                    SPECIFIED IN COLS. 55-60.                             -
CD                                                                          -
CD  12  67-72         ENDING STAGE NUMBER FOR WHICH THE COMPOSITION         -
CD                    SPECIFIED IN COLS. 13-18 RESIDES IN THE REGION OR ZONE -
CD                    SPECIFIED IN COLS. 55-60.                             -
C                                                                          -
CN                    CARD TYPES 35, 36, AND 37 ARE PERTINENT ONLY TO       -
CN                    NON-EQUILIBRIUM PROBLEMS.                             -
CN                                                                          -
CN                    IF BOTH TYPE 11 AND 35 CARDS ARE PRESENT, THE TYPE 11 -
CN                    CARDS WILL BE IGNORED.                                -
CN                                                                          -
CN                    IF COLS. 31-36 AND/OR 49-54 AND/OR 67-72 ARE BLANK OR 0-
CN                    THE ENDING STAGE NUMBER WILL BE SET EQUAL TO THE      -
CN                    BEGINNING STAGE NUMBER SPECIFIED IN COLS. 25-30 AND/OR -
CN                    43-48 AND/OR 61-66.                                   -
CN                                                                          -
CN                    FOR A GIVEN PATH, COLS. 19-24, 37-42, AND 55-60 MUST  -
CN                    EITHER BE ALL REGION LABELS, OR ALL FUEL MANAGEMENT   -
CN                    LABELS, OR ALL PRIMARY COMPOSITION (ZONE LABELS).  SEE -
CN                    CARD TYPE 45 FOR SPECIFICATION OF THE FUEL MANAGEMENT -
CN                    GROUPS.  IF ZONE LABELS ARE BEING USED, COLS. 13-18   -
CN                    MUST CONTAIN A SUB-ZONE LABEL.  IF REGION (OR FUEL    -
CN                    MANAGEMENT GROUP) LABELS ARE BEING USED, COLS. 13-18  -
CN                    MUST CONTAIN A ZONE LABEL.                            -
CN                                                                          -
CN                    IF ZONE LABELS OR FUEL MANAGEMENT GROUP LABELS ARE    -
CN                    BEING USED TO DEFINE A PATH, COLS. 19-24, 37-42, AND  -
CN                    55-60 MUST ALL CONTAIN THE SAME LABEL OR BE BLANK.    -
CN                    THIS IS NECESSARY SINCE IT IS NOT POSSIBLE TO KNOW    -
CN                    WHICH OF THE REGIONS ASSOCIATED WITH ONE OF THE STAGES -
CN                    IS CONNECTED WITH A PARTICULAR REGION IN THE NEXT STAGE-
CN                    IF THE FUEL IS BEING SHUFFLED.                        -
CN                                                                          -
CN                    IN STAGE 1 OF EACH PATH, THE ZONE/REGION OR           -
CN                    SUB-ZONE/ZONE CORRESPONDENCES MUST AGREE WITH THAT    -
CN                    IMPLIED FROM THE DATA SET A.NIP3 TYPE 14/15 CARDS.    -
CN                                                                          -
CN                    IF A NON-BLANK LABEL IS SPECIFIED IN COLS. 19-24,     -
CN                    37-42, AND.OR 55-60, AND THE CORRESPONDING BEGINNING  -
CN                    AND ENDING STAGE NUMBERS ARE BOTH 0, BOTH STAGE       -
CN                    NUMBERS WILL BE SET EQUAL TO 1.                       -
CN                                                                          -
CN                    STAGE NUMBERS MAY NOT OVERLAP IN A PARTICULAR PATH.   -
CN                    THUS THE FOLLOWING DATA (IN FREE FIELD FORMAT) WOULD  -
CN                    RESULT IN A FATAL INPUT ERROR...                      -
CN                    35 C1 R1 1 4 R2 5 8 R3 3 3                            -
CN                                                                          -
CN                    THE MATERIAL IDENTIFIED BY THE ZONE OR SUB-ZONE       -
CN                    LABEL IN COLS. 13-18 CAN BE SENT TO TEMPORARY STORAGE -
CN                    BY LEAVING ITS DESTINATION (COLS. 19-24 AND/OR 37-42  -
CN                    AND/OR 55-60) BLANK. THUS, IF COLS. 19-24 AND/OR 37-42 -
CN                    AND/OR 55-60 ARE BLANK, THE ZONE OR SUB-ZONE          -
CN                    SPECIFIED IN COLS. 13-18 WILL BE ASSUMED TO BE        -
CN                    TEMPORARILY DISCHARGED FOR THE STAGES SPECIFIED IN    -
CN                    COLS. 25-36 AND/OR 43-54 AND/OR 61-72.  NOTE HOWEVER, -
CN                    THE DESTINATION LABEL MAY NOT BE BLANK FOR STAGE 1.   -
CN                                                                          -
CN                    THE PATH SPECIFIED IS NON-REPETITIVE SO THAT THE      -
CN                    MATERIAL IDENTIFIED BY THE ZONE OR SUB-ZONE LABEL     -
```

```
CN                   IN COLS. 13-18 WILL BE PERMANENTLY DISCHARGED AFTER    -
CN                   THE LAST SPECIFIED STAGE.  HOWEVER, A PATH MAY BE       -
CN                   REPEATED BY MEANS OF THE TYPE 37 CARDS.                 -
CN                                                                          -
CN                   IF THE SMALLEST BEGINNING STAGE NUMBER FOR A PARTICULAR-
CN                   PATH IS GREATER THAN 1, COLS. 13-18 MUST CONTAIN A      -
CN                   PRIMARY COMPOSITION (ZONE) LABEL, AND COLS. 19-24,      -
CN                   37-42, AND 55-60 MUST CONTAIN REGION LABELS.  IN THIS   -
CN                   CASE, IT WILL BE ASSUMED THAT THE MATERIAL IDENTIFIED   -
CN                   BY THE ZONE LABEL IN COLS. 13-18 IS INTRODUCED AS       -
CN                   FRESH FUEL AT THAT STAGE IN THE PATH.                   -
C                                                                          -
C----------------------------------------------------------------------

C----------------------------------------------------------------------
CR          GENERAL FUEL MANAGEMENT PARAMETERS (TYPE 36)           -
C                                                                          -
CL    FORMAT-----(I2,4X,3E12.5,3I6,E12.5)                                  -
C                                                                          -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY             -
CD  =  =======  =========================================================-
CD  1  1-2      36                                                        -
CD                                                                        -
CD  2  7-18     BURN CYCLE TIME (IN DAYS)                                 -
CD                                                                        -
CD  3  19-30    SHUTDOWN TIME BETWEEN BURN CYCLES (IN DAYS)               -
CD                                                                        -
CD  4  31-42    RELATIVE REACTOR POWER (DEFAULT=1.0)                      -
CD                                                                        -
CD  5  43-48    BEGINNING STAGE NUMBER FOR WHICH THE ABOVE PARAMETERS     -
CD              APPLY                                                     -
CD                                                                        -
CD  6  49-54    ENDING STAGE NUMBER FOR WHICH THE ABOVE PARAMETERS        -
CD              APPLY                                                     -
CD                                                                        -
CD  7  55-60    NUMBER OF SUBINTERVALS INTO WHICH THE TOTAL BURN CYCLE -
CD              TIME IS TO BE DIVIDED (DEFAULT=1).                        -
CD                                                                        -
CD  8  61-72    DESIRED UNPOISONED KEFF(0)                                -
C                                                                          -
CN                   THE DEFAULT BURN CYCLE TIME, SHUTDOWN TIME BETWEEN     -
CN                   BURN CYCLES, AND NUMBER OF SUBINTERVALS FOR THE BURN   -
CN                   STEP ARE SPECIFIED ON THE TYPE 03 CARD ABOVE. THE      -
CN                   DEFAULT REACTOR POWER WILL BE WHATEVER WAS SPECIFIED   -
CN                   FOR THE NEUTRONICS CALCULATION BEING USED.  THE DEFAULT-
CN                   DESIRED UNPOISONED KEFF(0) IS SPECIFIED ON THE TYPE 04 -
CN                   CARD ABOVE.                                            -
CN                                                                          -
CN                   NOTE THAT THE FRACTION OF THE TOTAL BURN TIME AT       -
CN                   WHICH KEFF(0) IS TO BE REACHED AS SPECIFIED ON THE     -
CN                   TYPE 04 CARD ABOVE WILL BE USED FOR EACH OF THE BURN   -
CN                   CYCLES.                                                -
CN                                                                          -
CN                   STAGE 1 WILL ALWAYS USE THESE DATA REGARDLESS OF THE   -
CN                   DATA SUPPLIED ON THE TYPE 36 CARDS.  FOR STAGES 2 AND  -
CN                   LARGER, ANY STAGE NOT SPECIFIED ON THE TYPE 36 CARDS   -
CN                   WILL USE THE DEFAULT VALUES INDICATED ABOVE.           -
CN                                                                          -
CN                   IF COLS. 49-54 ARE 0 OR BLANK, THE ENDING STAGE NUMBER -
CN                   WILL BE SET EQUAL TO THE BEGINNING STAGE NUMBER        -
CN                   SPECIFIED IN COLS 43-48.                               -
C                                                                          -
C----------------------------------------------------------------------

C----------------------------------------------------------------------
CR          GENERAL FUEL MANAGEMENT REPETITION FACTORS (TYPE 37)      -
C                                                                          -
CL    FORMAT-----(I2,4X,5(A6,I6))                                         -
C                                                                          -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY             -
CD  =  =======  =========================================================-
CD  1  1-2      37                                                        -
```

```
CD                                                                         -
CD  2   7-12    PATH LABEL                                                  -
CD                                                                         -
CD  3   13-18   NUMBER OF TIMES THE PATH SPECIFIED IN COLS. 7-12 IS   -
CD              TO BE REPEATED (DEFAULT=0)                                  -
CD                                                                         -
CD  4   19-24   PATH LABEL                                                  -
CD                                                                         -
CD  5   25-30   NUMBER OF TIMES THE PATH SPECIFIED IN COLS. 19-24 IS  -
CD              TO BE REPEATED (DEFAULT=0)                                  -
CD                                                                         -
CD  6   31-36   PATH LABEL                                                  -
CD                                                                         -
CD  7   37-42   NUMBER OF TIMES THE PATH SPECIFIED IN COLS. 31-36 IS  -
CD              TO BE REPEATED (DEFAULT=0)                                  -
CD                                                                         -
CD  8   43-48   PATH LABEL                                                  -
CD                                                                         -
CD  9   49-54   NUMBER OF TIMES THE PATH SPECIFIED IN COLS. 43-48 IS  -
CD              TO BE REPEATED (DEFAULT=0)                                  -
CD                                                                         -
CD 10   55-60   PATH LABEL                                                  -
CD                                                                         -
CD 11   61-66   NUMBER OF TIMES THE PATH SPECIFIED IN COLS. 55-60 IS  -
CD              TO BE REPEATED (DEFAULT=0)                                  -
C                                                                          -
CN              THE TYPE 37 CARDS ARE PERTINENT ONLY IF TYPE 35 CARDS -
CN              ARE PROVIDED.                                               -
CN                                                                         -
CN              AFTER COMPLETION OF A PATH AS SPECIFIED ON THE TYPE 35 -
CN              CARDS, IF THAT PATH IS ALSO SPECIFIED ON A TYPE 37     -
CN              CARD, IT WILL BE REPEATED AS MANY TIMES AS SPECIFIED   -
CN              BY THE TYPE 37 CARD DATA.                                  -
C                                                                          -
C--------------------------------------------------------------------------

C--------------------------------------------------------------------------
CR          TIME DEPENDENT CONTROL ROD POSITIONS (TYPE 38)            -
C                                                                          -
CL    FORMAT-----(I2,4X,A6,4E12.5)                                         -
C                                                                          -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY               -
CD  =  =======  ========================================================-
CD  1   1-2     38                                                         -
CD                                                                         -
CD  2   7-12    CONTROL-ROD BANK LABEL (REPEATED ON ADDITIONAL        -
CD              TYPE 38 CARDS IF NECESSARY).                               -
CD                                                                         -
CD  3   13-24   TIME (DAYS).                                               -
CD                                                                         -
CD  4   25-36   AXIAL POSITION OF THE CONTROL-ROD BANK TIP AT THE     -
CD              TIME SPECIFIED IN COLS. 13-24 (CM).                        -
CD                                                                         -
CD  5   37-48   TIME (DAYS).                                               -
CD                                                                         -
CD  6   49-60   AXIAL POSITION OF THE CONTROL-ROD BANK TIP AT THE     -
CD              TIME SPECIFIED IN COLS. 37-48 (CM).                        -
C                                                                          -
CN              TYPE 38 CARDS MUST BE SUPPLIED IF CONTROL RODS HAVE   -
CN              BEEN SPECIFIED ON THE DATA SET A.NIP3 TYPE 44 CARDS.  -
CN                                                                         -
CN              THE CONTROL-ROD BANK LABELS IN COLS. 7-12 CORRESPOND TO-
CN              THE LABELS SPECIFIED IN COLS. 7-12 ON THE DATA SET    -
CN              A.NIP3 TYPE 44 CARDS.  IF ONLY ONE CONTROL-ROD BANK   -
CN              IS INVOLVED, COLS. 7-12 MAY BE BLANK.                      -
CN                                                                         -
CN              IF COLS. 37-48 AND 49-60 ARE BOTH 0.0 OR BLANK, THESE -
CN              FIELDS WILL BE IGNORED.                                    -
CN                                                                         -
CN              ROD POSITIONS AT THE ENDS OF EACH SUBINTERVAL DURING  -
CN              THE BURN CYCLE WILL BE DETERMINED BY LINEAR           -
CN              INTERPOLATION OF THE DATA SUPPLIED ON THESE CARDS.    -
```

49

```
CN                                                                        -
CN              IF TYPE 38 CARDS ARE NOT SUPPLIED FOR A CONTROL-ROD       -
CN              BANK WHICH IS SPECIFIED ON THE DATA SET A.NIP3 TYPE        -
CN              44 CARDS, THE CONTROL RODS IN THAT BANK WILL REMAIN AT     -
CN              THE POSITIONS SPECIFIED ON THE A.NIP3 DATA THROUGHOUT      -
CN              THE COURSE OF THE PROBLEM.                                 -
CN                                                                        -
CN              IF MORE THAN ONE AXIAL POSITION IS SPECIFIED FOR A         -
CN              PARTICULAR TIME, THE FIRST AXIAL POSITION ENCOUNTERED      -
CN              WILL BE USED FOR INTERPOLATION AT EARLIER SUBINTERVAL      -
CN              TIME POINTS, AND THE LAST ROD POSITION SPECIFIED FOR       -
CN              THAT PARTICULAR TIME WILL BE USED FOR LATER                -
CN              SUBINTERVAL TIME POINTS.                                   -
CN                                                                        -
CN              THE ROD POSITION SPECIFIED FOR THE EARLIEST TIME ON        -
CN              ANY OF THE TYPE 38 CARDS FOR THE RODS IN A PARTICULAR      -
CN              CONTROL-ROD BANK WILL BE USED FOR THOSE RODS AT ANY        -
CN              EARLIER SUBINTERVAL TIME.  SUBINTERVAL TIMES WHICH ARE -
CN              LATER THAN THE LATEST TIME SPECIFIED ON ANY OF THE TYPE-
CN              38 CARDS FOR THE RODS IN THAT PARTICULAR CONTROL-ROD       -
CN              BANK WILL USE THE POSITION SPECIFIED FOR THAT LATEST       -
CN              TIME.                                                      -
CN                                                                        -
CN              THE FIGURE BELOW ILLUSTRATES THE INTERPOLATION RULES       -
CN              DESCRIBED ABOVE.                                           -
CN                                                                        -
CN         Z3    |        |         |      *     X          X             -
CN               |        |         |            |          |             -
CN         Z1    X    *   |         X            |          |             -
CN               |        |         |            |          |             -
CN         Z22   |        X    +    |            |          |             -
CN               |        |         |            |          |             -
CN         Z2    |        |    *    |            |          |             -
CN                                                                        -
CN              T0   T(1)  T1  T(2)  T2  T(3)  T3         T4              -
CN                                                                        -
CN              THE VERTICAL LINES CORRESPOND TO THE SUBINTERVAL          -
CN              TIME BOUNDARIES, THE * AND + ARE INPUT VALUES SUPPLIED -
CN              ON THE TYPE 38 CARDS, AND THE X ARE THE RESULTING          -
CN              VALUES USED FOR THE ROD POSITIONS.  THE SUBINTERVAL        -
CN              TIME POINTS ARE T0, T1, T2, AND T3 AND THE INPUT DATA      -
CN              ARE SUPPLIED AT TIMES T(1), T(2), AND T(3).               -
CN              NOTE THAT ANY OF THE INPUT TIMES MIGHT HAVE COINCIDED      -
CN              WITH ONE OF THE SUBINTERVAL TIME POINTS.                   -
CN              SINCE T0 FALLS BELOW THE EARLIEST INPUT VALUE AT           -
CN              T(1), THE ROD POSITION WILL BE DETERMINED BY THAT          -
CN              EARLIEST DATA POINT.  THE + DATA POINT IS ASSUMED TO       -
CN              HAVE BEEN SUPPLIED AFTER THE * POINT AND AT THE SAME       -
CN              TIME T(2) SO IT WILL BE USED FOR INTERPOLATIONS AT         -
CN              LATER TIMES.  THE VALUE USED AT TIME POINTS T3 AND T4      -
CN              ARE DETERMINED BY THE DATA POINT AT T(3).                  -
CN              USING FREE FORMAT STYLE INPUT, THE INPUT FOR THE           -
CN              EXAMPLE ABOVE MIGHT HAVE BEEN GIVEN AS                     -
CN                                                                        -
CN                 38   BANK1  T(1) Z1  T(2) Z2                            -
CN                 38   BANK1  T(3) Z3  T(2) Z4                            -
CN                 38   BANK1  T(2) Z22                                    -
CN                                                                        -
CN              NOTE THAT THREE POSITIONS HAVE BEEN SPECIFIED FOR TIME -
CN              T(2).  THE LAST ONE ENCOUNTERED, Z22, IS USED FOR          -
CN              INTERPOLATIONS AT SUBINTERVAL TIME POINTS LATER THAN       -
CN              T(2) AND THE FIRST ONE SPECIFIED, Z2, IS USED FOR          -
CN              INTERPOLATIONS AT SUBINTERVAL TIME POINTS EARLIER THAN -
CN              T(2).                                                      -
CN                                                                        -
CN              NOTE THAT IF THE INPUT DATA AT T(2) ABOVE HAD FALLEN       -
CN              AT T1, THE ROD POSITION AT T1 WOULD BE GIVEN BY THE *      -
CN              DATA POINT, AND THE + DATA POINT WOULD HAVE BEEN USED      -
CN              FOR DETERMINING THE POSITION AT T2.                        -
C                                                                         -
C-------------------------------------------------------------------------
```

50

```
C------------------------------------------------------------------------
CR          BURNUP DEPENDENT GROUPS (TYPE 39)                            -
C                                                                        -
CL    FORMAT-----(I2,4X,3(A6,2I6))                                       -
C                                                                        -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY                -
CD  =  ======   ===========================================================-
CD  1  1-2      39                                                       -
CD                                                                       -
CD  2  7-12     LABEL OF BURNUP DEPENDENT ISOTOPE.                       -
CD                                                                       -
CD  3  13-18    BEGINNING NUMBER OF THE GROUP FOR WHICH THE CROSS        -
CD              SECTIONS ARE TO BE MODIFIED.                             -
CD                                                                       -
CD  4  19-24    ENDING NUMBER OF THE GROUP FOR WHICH THE CROSS           -
CD              SECTIONS ARE TO BE MODIFIED.                             -
CD                                                                       -
CD  5  25-30    LABEL OF BURNUP DEPENDENT ISOTOPE.                       -
CD                                                                       -
CD  6  31-36    BEGINNING NUMBER OF THE GROUP FOR WHICH THE CROSS        -
CD              SECTIONS ARE TO BE MODIFIED.                             -
CD                                                                       -
CD  7  37-42    ENDING NUMBER OF THE GROUP FOR WHICH THE CROSS           -
CD              SECTIONS ARE TO BE MODIFIED.                             -
CD                                                                       -
CD  8  43-48    LABEL OF BURNUP DEPENDENT ISOTOPE.                       -
CD                                                                       -
CD  9  49-54    BEGINNING NUMBER OF THE GROUP FOR WHICH THE CROSS        -
CD              SECTIONS ARE TO BE MODIFIED.                             -
CD                                                                       -
CD 10  55-60    ENDING NUMBER OF THE GROUP FOR WHICH THE CROSS           -
CD              SECTIONS ARE TO BE MODIFIED.                             -
C                                                                        -
CN              THE CROSS SECTIONS FOR THE ISOTOPES SPECIFIED IN COLS. -
CN              7-12, 25-30, AND 43-48 WILL BE MODIFIED FOR THE GROUPS -
CN              SPECIFIED IN COLS. 13-24, 31-42, AND 49-60.             -
CN                                                                       -
CN              IF COLS. 19-24, 37-42, OR 55-60 ARE BLANK OR 0, THE    -
CN              CROSS SECTIONS WILL BE MODIFIED FOR THE GROUP SPECIFIED-
CN              IN COLS. 13-18, 31-36, OR 49-54, RESPECTIVELY.          -
CN                                                                       -
CN              IF COLS. 13-18, 31-36, OR 59-54 ARE 0 OR BLANK ON THE  -
CN              FIRST TYPE 39 CARD FOR A PARTICULAR BURNUP DEPENDENT    -
CN              ISOTOPE, THE CROSS SECTIONS FOR THAT ISOTOPE WILL BE    -
CN              MODIFIED FOR ALL GROUPS.                                -
CN                                                                       -
CN              IF COLS. 7-12, 25-30, OR 43-48 ARE BLANK, THE REST OF  -
CN              THE DATA ON THAT CARD WILL BE IGNORED.                  -
CN                                                                       -
CN              THE TYPE 39 CARDS ARE NOT PERTINENT UNLESS TYPE 26     -
CN              CARDS HAVE BEEN SUPPLIED.                               -
C                                                                        -
C------------------------------------------------------------------------


C------------------------------------------------------------------------
CR          BURNUP DEPENDENT REACTIONS (TYPE 40)                        -
C                                                                        -
CL    FORMAT-----(I2,4X,2(A6,I6,E12.5,I6)                               -
C                                                                        -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY                -
CD  =  ======   ===========================================================-
CD  1  1-2      40                                                       -
CD                                                                       -
CD  2  7-12     LABEL OF BURNUP DEPENDENT ISOTOPE.                       -
CD                                                                       -
CD  3  13-18    0...CAPTURE CROSS SECTIONS (POLYNOMIAL FIT)              -
CD              1...FISSION CROSS SECTIONS (POLYNOMIAL FIT)              -
CD              2...BOTH CAPTURE AND FISSION CROSS SECTIONS             -
CD                 (POLYNOMIAL FIT)                                      -
CD              31...(N,GAMMA) CROSS SECTIONS (SPLINE FIT)              -
```

51

```
CD                  32...FISSION CROSS SECTIONS (SPLINE FIT)            -
CD                  33...(N,P) CROSS SECTIONS (SPLINE FIT)              -
CD                  34...(N,ALPHA) CROSS SECTIONS (SPLINE FIT)          -
CD                  39...(N,D) CROSS SECTIONS (SPLINE FIT)              -
CD                  40...(N,T) CROSS SECTIONS (SPLINE FIT)              -

CD                                                                      -
CD  4  19-30  ALLOWABLE ERROR IN THE ABSOLUTE VALUE OF THE RELATIVE     -
CD           RESIDUAL FOR ANY OF THE POINTS USED IN THE POLYNOMIAL      -
CD           FIT (DEFAULT=1.0E-3).                                      -
CD           NOT USED FOR SPLINE FIT                                    -
CD                                                                      -
CD  5  31-36  MAXIMUM ORDER FOR THE POLYNOMIAL FIT (DEFAULT=8).         -
CD           NOT USED FOR SPLINE FIT                                    -
CD                                                                      -
CD  6  37-42  LABEL OF BURNUP DEPENDENT ISOTOPE.                        -
CD                                                                      -
CD  7  43-48  0...CAPTURE CROSS SECTIONS  (POLYNOMIAL FIT)              -
CD           1...FISSION CROSS SECTIONS  (POLYNOMIAL FIT)               -
CD           2...BOTH CAPTURE AND FISSION CROSS SECTIONS                -
CD              (POLYNOMIAL FIT)                                        -
CD           31...(N,GAMMA) CROSS SECTIONS (SPLINE FIT)                 -
CD           32...FISSION CROSS SECTIONS (SPLINE FIT)                   -
CD           33...(N,P) CROSS SECTIONS (SPLINE FIT)                     -
CD           34...(N,ALPHA) CROSS SECTIONS (SPLINE FIT)                 -
CD           39...(N,D) CROSS SECTIONS (SPLINE FIT)                     -
CD           40...(N,T) CROSS SECTIONS (SPLINE FIT)                     -

CD                                                                      -
CD  8  49-60  ALLOWABLE ERROR IN THE ABSOLUTE VALUE OF THE RELATIVE     -
CD           RESIDUAL FOR ANY OF THE POINTS USED IN THE POLYNOMIAL      -
CD           FIT (DEFAULT=1.0E-3).                                      -
CD           NOT USED FOR SPLINE FIT                                    -
CD                                                                      -
CD  9  61-66  MAXIMUM ORDER FOR THE POLYNOMIAL FIT (DEFAULT=8).         -
CD           NOT USED FOR SPLINE FIT                                    -
CD                                                                      -
CN           SPLINE FIT:                                                -
CN           THE CROSS SECTIONS WILL BE ASSUMED TO VARY ACCORDING       -
CN           TO A CUBIC SPLINE FIT OF THE ATOMIC DENSITY                -
CN           OF THE REFERENCE BASE ISOTOPE.                             -
CN            THE FIT PASSES SMOOTHLY THROUGH THE POINTS.               -
CN                                                                      -
CN           POLYNOMIAL FIT:                                            -
CN           THE CROSS SECTIONS WILL BE ASSUMED TO VARY ACCORDING       -
CN           TO A POLYNOMIAL EXPANSION OF THE ATOMIC DENSITY            -
CN           OF THE REFERENCE BASE ISOTOPE SO THAT                      -
CN                                                                      -
CN               F = A0 + A1*C + A2*(C**2) +...+ AN*(C**N)              -
CN                                                                      -
CN           WHERE C IS THE ATOMIC DENSITY AND N IS THE ORDER           -
CN           OF THE FIT.  THE MULTIPLICATIVE FACTOR F WILL BE           -
CN           OBTAINED SEPARATELY FOR THE CROSS SECTION TYPES            -
CN           SPECIFIED IN COLS. 13-18 AND 43-48.                        -
CN                                                                      -
CN           IF COLS. 31-36 OR 61-66 ARE NEGATIVE, THE CROSS            -
CN           SECTIONS FOR THE CORRESPONDING ISOTOPE WILL BE             -
CN           ASSUMED TO VARY ACCORDING TO THE ABOVE POLYNOMIAL          -
CN           EXPRESSION BUT WHERE C IS THE NATURAL LOGARITHM OF         -
CN           THE ATOMIC DENSITY OF THE REFERENCE BASE ISOTOPE           -
CN           RATHER THAN JUST THE ATOMIC DENSITY ITSELF.                -
CN           THE LOGARITHMIC FITTING OPTION SHOULD BE USED WHEN         -
CN           ORDINARY LINEAR-LINEAR FITTING PRODUCES UNACCEPTABLE       -
CN           RESULTS.   TYPICALLY, THE LOGARITHMIC FITTING WILL         -
CN           BE APPROPRIATE THEN THE ATOMIC DENSITIES VARY OVER A       -
CN           NUMBER OF ORDERS OF MAGNITUDE.                             -
CN                                                                      -
CN           THE RESIDUALS REFERRED TO IN COLS. 19-30 AND 49-60         -
CN           ARE OBTAINED AT EACH OF THE ATOM DENSITIES SPECIFIED ON-
CN           THE TYPE 41 CARDS.                                         -
CN                                                                      -
CN           IF COLS. 7-12 OR 37-42 ARE BLANK, THE REST OF THE DATA -
```

```
CN                      ON THAT CARD WILL BE IGNORED.                      -
CN                                                                         -
CN                      THE TYPE 40 CARDS ARE NOT PERTINENT UNLESS TYPE 26 -
CN                      CARDS HAVE BEEN SUPPLIED.                          -
C                                                                         -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR          BURNUP DEPENDENT FITTING DATA SPECIFICATIONS (TYPE 41)   -
C                                                                         -
CL     FORMAT-----(I2,4X,A6,2(A6,2E12.5))                                 -
C                                                                         -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY                   -
CD  =  =======  =======================================================-
CD  1  1-2      41                                                        -
CD                                                                        -
CD  2  7-12     LABEL OF BURNUP DEPENDENT ISOTOPE.                        -
CD                                                                        -
CD  3  13-18    LABEL OF THE ISOTOPE WHOSE CROSS SECTIONS ARE TO BE       -
CD              INCLUDED IN THE POLYNOMIAL FITTING OF CROSS SECTION       -
CD              VS. THE ATOMIC DENSITY OF THE CORRESPONDING REFERENCE     -
CD              BASE ISOTOPE.                                             -
CD                                                                        -
CD  4  19-30    THE REFERENCE BASE ISOTOPE ATOMIC DENSITY                 -
CD              CORRESPONDING TO THE CROSS SECTIONS OF THE ISOTOPE        -
CD              REFERENCED IN COLS. 13-18.                                -
CD                                                                        -
CD  5  31-42    WEIGHT FOR THE DATA AT THE ATOMIC DENSITY IN COLS.        -
CD              19-30 (DEFAULT=1.0).                                      -
CD                                                                        -
CD  6  43-48    LABEL OF THE ISOTOPE WHOSE CROSS SECTIONS ARE TO BE       -
CD              INCLUDED IN THE POLYNOMIAL FITTING OF CROSS SECTION       -
CD              VS. THE ATOMIC DENSITY OF THE CORRESPONDING REFERENCE     -
CD              BASE ISOTOPE.                                             -
CD                                                                        -
CD  7  49-60    THE REFERENCE BASE ISOTOPE ATOMIC DENSITY                 -
CD              CORRESPONDING TO THE CROSS SECTIONS OF THE ISOTOPE        -
CD              REFERENCED IN COLS. 43-48.                                -
CD                                                                        -
CD  8  61-72    WEIGHT FOR THE DATA AT THE ATOMIC DENSITY IN COLS.        -
CD              49-60 (DEFAULT=1.0).                                      -
C                                                                         -
CN              COLS. 7-12 AND 13-18 MAY NOT BE BLANK.                    -
CN                                                                        -
CN              THESE DATA ARE USED TO OBTAIN THE COEFICIENTS OF A        -
CN              POLYNOMIAL EXPANSION (SEE CARD TYPE 40) USING A LEAST     -
CN              SQUARES FITTING PROCEDURE.  THE CODE WILL ADJUST THE      -
CN              ORDER OF THE POLYNOMIAL UNTIL THE ABSOLUTE VALUE OF THE-
CN              RELATIVE RESIDUAL AT ANY OF THE DATA POINTS IS LESS       -
CN              THAN OR EQUAL TO THE ERROR SPECIFIED ON THE TYPE 40       -
CN              CARDS.  NOTE THAT THE ORDER OF THE FIT WILL IN GENERAL -
CN              VARY FROM GROUP TO GROUP AND BE DIFFERENT FOR CAPTURE     -
CN              AND FISSION.                                              -
CN                                                                        -
CN              THE ORDER OF THE POLYNOMIAL FIT SPECIFIED BY THE          -
CN              ABSOLUTE VALUE OF THE QUANTITY IN COLS. 31-36 OR          -
CN              OR 61-66 ON A TYPE 40 CARD FOR THE BURNUP DEPENDENT       -
CN              ISOTOPE IN COLS. 7-12 ON A TYPE 41 CARD MUST BE LESS      -
CN              THAN THE NUMBER OF ISOTOPES USED IN THE FITTING OF        -
CN              THAT BURNUP DEPENDENT ISOTOPE ON THE TYPE 41 CARDS.       -
CN              THUS IF 5 ISOTOPES ARE SPECIFIED ON THE TYPE 41 CARDS     -
CN              IN 13-18 AND 43-48, COLS. 31-36 OR 61-66 ON A TYPE 40     -
CN              CARD MUST BE 4 OR LESS FOR THE CORRESPONDING BURNUP       -
CN              DEPENDENT ISOTOPE.                                        -
CN                                                                        -
CN              NOTE THAT CONTRARY TO THE ISOTOPES SPECIFIED ON THE       -
CN              TYPE 26 CARDS, THE ISOTOPES USED FOR THE FITTING          -
CN              SPECIFIED IN COLS. 13-18 AND 43-48 ARE NORMALLY NOT       -
CN              INCLUDED IN THE REBUS-3 CALCULATION PER SE.  THUS, THE -
CN              LABELS IN COLS. 13-18 AND 43-48 NORMALLY WILL NOT         -
CN              APPEAR ON THE TYPE 09 OR 10 CARDS NOR ON THE TYPE 13      -
```

53

```
CN                   AND/OR TYPE 14 CARDS OF DATA SET A.NIP3.           -
CN                                                                     -
CN                   IF THE ATOMIC DENSITY DURING THE COURSE OF THE PROBLEM -
CN                   FALLS OUTSIDE THE RANGE OF DENSITIES SPECIFIED ON THE  -
CN                   TYPE 41 CARD FOR THE PARTICULAR REFERENCE BASE ISOTOPE,-
CN                   THE PROBLEM WILL BE TERMINATED WITH A FATAL ERROR  -
CN                   MESSAGE.                                           -
CN                                                                     -
CN                   IF A WEIGHT OF 0.0 IS DESIRED, THAT VALUE MUST BE USED -
CN                   EXPLICITLY IN COLS. 31-42 OR 61-72 SINCE A WEIGHT OF   -
CN                   1.0 WILL BE USED IF THOSE COLUMNS ARE LEFT BLANK.  -
CN                                                                     -
CN                   THE TYPE 41 CARDS ARE NOT PERTINENT UNLESS TYPE 26 -
CN                   CARDS HAVE BEEN SUPPLIED.                          -
CN                                                                     -
CN                   IF A.BURN IS FIXED-FORMAT, REFERENCE BASE ISOTOPE ATOMIC-
CN                   DENSITY INFORMATION ON FIELDS #4 OR #7 CAN BE SUPPLIED -
CN                   AS ZERO OR BLANK IF THE USER WISHES TO LET THE POLYFI  -
CN                   MODULE FIND THIS DATA FROM FILE ISOTXS.  NOTE THAT IF  -
CN                   A.BURN IS FREE-FORMAT, THEN THE USER MUST INSERT AT    -
CN                   LEAST A DECIMAL POINT IN THESE FIELDS IN ORDER TO  -
CN                   PROCESS CARD TYPE 41 CORRECTLY. THE USER HAS COMPLETE  -
CN                   FREEDOM TO MIX SUPPLIED INFORMATION WITH DATA TO BE    -
CN                   FOUND FROM ISOTXS. IN OTHER WORDS, YOU CAN OVERRIDE    -
CN                   THE ISOTXS INFORMATION FOR A GIVEN ISOTOPE BURN POINT  -
CN                   BY NOT NAMING THAT ISOTOPE ON A TYPE 46 CARD, AND BY   -
CN                   SUPPLYING THE BURN POINT INFORMATION AS USUAL ON A -
CN                   TYPE 41 CARD. THE USER IS INFORMED OF THE BURN POINT   -
CN                   ATOM DENSITY UPDATES TAKEN FROM ISOTXS.            -
C                                                                     -
C---------------------------------------------------------------------


C---------------------------------------------------------------------
CR            NON-EQUILIBRIUM DISCHARGE RECOVERY FACTOR SPECIFICATIONS  -
CR            (TYPE 42)                                                -
C                                                                     -
CL    FORMAT-----(I2,4X,A6,6X,3(A6,E12.5))                            -
C                                                                     -
CD  #  COLUMNS           CONTENTS...IMPLICATION, IF ANY               -
CD  =  =======  =========================================================-
CD  1  1-2      42                                                    -
CD                                                                     -
CD  2  7-12     DISCHARGE RECOVERY FACTOR SPECIFICATION LABEL (REPEATED-
CD              ON ADDITIONAL CARDS, IF NECESSARY).                   -
CD                                                                     -
CD  3  19-24    ACTIVE ISOTOPE LABEL.                                 -
CD                                                                     -
CD  4  25-36    RECOVERY FACTOR (DEFAULT=0.0).                        -
CD                                                                     -
CD  5  37-42    ACTIVE ISOTOPE LABEL.                                 -
CD                                                                     -
CD  6  43-54    RECOVERY FACTOR (DEFAULT=0.0).                        -
CD                                                                     -
CD  7  55-60    ACTIVE ISOTOPE LABEL.                                 -
CD                                                                     -
CD  8  61-72    RECOVERY FACTOR (DEFAULT=0.0).                        -
C                                                                     -
CN                   ALL ACTIVE ISOTOPE LABELS MUST BE DEFINED ON TYPE 09  -
CN                   CARDS OR VIA THE PRESTORED BURNUP CHAINS.          -
CN                                                                     -
CN                   ANY ACTIVE ISOTOPE LABEL APPEARING ON A TYPE 42 CARD  -
CN                   MUST ALSO BE SPECIFIED ON THE TYPE 18 AND TYPE 13 -
CN                   CARDS.                                             -
CN                                                                     -
CN                   THE RECOVERY FACTORS WILL BE APPLIED TO THE AMOUNTS OF -
CN                   FUEL DISCHARGED FROM THE VARIOUS REGIONS SPECIFIED ON  -
CN                   THE TYPE 43 CARDS BELOW FOR NON-EQUILIBRIUM PROBLEMS.  -
CN                                                                     -
CN                   ANY ACTIVE ISOTOPE NOT SPECIFIED FOR A PARTICULAR -
CN                   DISCHARGE RECOVERY FACTOR SPECIFICATION LABEL WILL BE  -
CN                   ASSIGNED A RECOVERY FACTOR OF 0.0.                -
```

```
C                                                                            -
C----------------------------------------------------------------------------


C----------------------------------------------------------------------------
CR          NON-EQUILIBRIUM DISCHARGE REGIONS SPECIFICATIONS (TYPE 43) -
C                                                                            -
CL     FORMAT-----(I2,4X,A6,10A6)                                            -
C                                                                            -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY                      -
CD  =  ======  ============================================================-
CD  1  1-2     43                                                           -
CD                                                                          -
CD  2  7-12    DISCHARGE RECOVERY FACTOR SPECIFICATION LABEL (REPEATED-
CD             ON ADDITIONAL CARDS, IF NECESSARY).                          -
CD                                                                          -
CD  3  13-18   LABEL OF REGION OR AREA TO WHICH THE RECOVERY FACTORS  -
CD             ON THE TYPE 42 CARDS FOR THE LABEL IN COLS. 7-12 WILL  -
CD             BE APPLIED FOR DISCHARGED FUEL.                         -
CD                                                                          -
CD  4  19-24   LABEL OF REGION OR AREA TO WHICH THE RECOVERY FACTORS  -
CD             ON THE TYPE 42 CARDS FOR THE LABEL IN COLS. 7-12 WILL  -
CD             BE APPLIED FOR DISCHARGED FUEL.                         -
CD                                                                          -
CD  5  25-30   LABEL OF REGION OR AREA TO WHICH THE RECOVERY FACTORS  -
CD             ON THE TYPE 42 CARDS FOR THE LABEL IN COLS. 7-12 WILL  -
CD             BE APPLIED FOR DISCHARGED FUEL.                         -
CD                                                                          -
CD  6  31-36   LABEL OF REGION OR AREA TO WHICH THE RECOVERY FACTORS  -
CD             ON THE TYPE 42 CARDS FOR THE LABEL IN COLS. 7-12 WILL  -
CD             BE APPLIED FOR DISCHARGED FUEL.                         -
CD                                                                          -
CD  7  37-42   LABEL OF REGION OR AREA TO WHICH THE RECOVERY FACTORS  -
CD             ON THE TYPE 42 CARDS FOR THE LABEL IN COLS. 7-12 WILL  -
CD             BE APPLIED FOR DISCHARGED FUEL.                         -
CD                                                                          -
CD  8  43-48   LABEL OF REGION OR AREA TO WHICH THE RECOVERY FACTORS  -
CD             ON THE TYPE 42 CARDS FOR THE LABEL IN COLS. 7-12 WILL  -
CD             BE APPLIED FOR DISCHARGED FUEL.                         -
CD                                                                          -
CD  9  49-54   LABEL OF REGION OR AREA TO WHICH THE RECOVERY FACTORS  -
CD             ON THE TYPE 42 CARDS FOR THE LABEL IN COLS. 7-12 WILL  -
CD             BE APPLIED FOR DISCHARGED FUEL.                         -
CD                                                                          -
CD 10  55-60   LABEL OF REGION OR AREA TO WHICH THE RECOVERY FACTORS  -
CD             ON THE TYPE 42 CARDS FOR THE LABEL IN COLS. 7-12 WILL  -
CD             BE APPLIED FOR DISCHARGED FUEL.                         -
CD                                                                          -
CD 11  61-66   LABEL OF REGION OR AREA TO WHICH THE RECOVERY FACTORS  -
CD             ON THE TYPE 42 CARDS FOR THE LABEL IN COLS. 7-12 WILL  -
CD             BE APPLIED FOR DISCHARGED FUEL.                         -
CD                                                                          -
CD 12  67-72   LABEL OF REGION OR AREA TO WHICH THE RECOVERY FACTORS  -
CD             ON THE TYPE 42 CARDS FOR THE LABEL IN COLS. 7-12 WILL  -
CD             BE APPLIED FOR DISCHARGED FUEL.                         -
C                                                                          -
CN             THE FUEL DISCHARGED FROM THE VARIOUS REGIONS SPECIFIED -
CN             ABOVE WILL BE COMBINED, AFTER APPLYING THE RECOVERY    -
CN             FACTORS SPECIFIED ON THE TYPE 42 CARDS TO FORM THE     -
CN             FEED COMPOSITIONS FOR THE VARIOUS FEEDS AS SPECIFIED    -
CN             ON THE TYPE 44 CARDS.                                    -
C                                                                          -
C----------------------------------------------------------------------------


C----------------------------------------------------------------------------
CR          NON-EQUILIBRIUM FEED MODIFICATION SPECIFICATIONS (TYPE 44) -
C                                                                          -
CL     FORMAT-----(I2,4X,A6,10A6)                                          -
C                                                                          -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY                    -
CD  =  ======  ============================================================-
```

```
CD   1   1-2      44                                                      -
CD                                                                        -
CD   2   7-12     EXTERNAL FEED LABEL (REPEATED ON ADDITIONAL CARDS, IF   -
CD                NECESSARY).                                             -
CD                                                                        -
CD   3   13-18    LABEL OF REGION OR AREA CONTRIBUTING TO THE COMPOSITION-
CD                OF THE EXTERNAL FEED SPECIFIED IN COLS. 7-12.           -
CD                                                                        -
CD   4   19-24    LABEL OF REGION OR AREA CONTRIBUTING TO THE COMPOSITION-
CD                OF THE EXTERNAL FEED SPECIFIED IN COLS. 7-12.           -
CD                                                                        -
CD   5   25-30    LABEL OF REGION OR AREA CONTRIBUTING TO THE COMPOSITION-
CD                OF THE EXTERNAL FEED SPECIFIED IN COLS. 7-12.           -
CD                                                                        -
CD   6   31-36    LABEL OF REGION OR AREA CONTRIBUTING TO THE COMPOSITION-
CD                OF THE EXTERNAL FEED SPECIFIED IN COLS. 7-12.           -
CD                                                                        -
CD   7   37-42    LABEL OF REGION OR AREA CONTRIBUTING TO THE COMPOSITION-
CD                OF THE EXTERNAL FEED SPECIFIED IN COLS. 7-12.           -
CD                                                                        -
CD   8   43-48    LABEL OF REGION OR AREA CONTRIBUTING TO THE COMPOSITION-
CD                OF THE EXTERNAL FEED SPECIFIED IN COLS. 7-12.           -
CD                                                                        -
CD   9   49-54    LABEL OF REGION OR AREA CONTRIBUTING TO THE COMPOSITION-
CD                OF THE EXTERNAL FEED SPECIFIED IN COLS. 7-12.           -
CD                                                                        -
CD 10   55-60    LABEL OF REGION OR AREA CONTRIBUTING TO THE COMPOSITION-
CD                OF THE EXTERNAL FEED SPECIFIED IN COLS. 7-12.           -
CD                                                                        -
CD 11   61-66    LABEL OF REGION OR AREA CONTRIBUTING TO THE COMPOSITION-
CD                OF THE EXTERNAL FEED SPECIFIED IN COLS. 7-12.           -
CD                                                                        -
CD 12   67-72    LABEL OF REGION OR AREA CONTRIBUTING TO THE COMPOSITION-
CD                OF THE EXTERNAL FEED SPECIFIED IN COLS. 7-12.           -
C                                                                         -
CN               THE EXTERNAL FEED LABELS SPECIFIED IN COLS. 7-12 MUST    -
CN               CORRESPOND TO LABELS SPECIFIED ON THE TYPE 21 CARDS.     -
CN                                                                        -
CN               THE COMPOSITION OF THE EXTERNAL FEED SPECIFIED IN COLS.-
CN               7-12 WILL BE DETERMINED BY THE SUM OF ALL OF THE FUEL    -
CN               DISCHARGED FROM THE REGIONS SPECIFIED IN COLS. 13-72     -
CN               AFTER APPLYING THE RECOVERY FACTORS SPECIFIED ON THE     -
CN               TYPE 42 CARDS.                                           -
CN                                                                        -
CN               ANY EXTERNAL FEED NOT SPECIFIED ON A TYPE 44 CARD WILL  -
CN               RETAIN THE ISOTOPIC COMPOSITION PREVIOUSLY ASSIGNED      -
CN               EITHER VIA THE ORIGINAL INPUT DATA (SEE CARD TYPES       -
CN               21 AND 22) OR DUE TO DISCHARGE FROM PREVIOUSLY           -
CN               DISCHARGED FUEL.                                         -
C                                                                         -
C------------------------------------------------------------------------


C------------------------------------------------------------------------
CR            FUEL MANAGEMENT GROUP SPECIFICATIONS (TYPE 45)             -
C                                                                         -
CL     FORMAT-----(I2,4X,11A6)                                           -
C                                                                         -
CD   #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY                -
CD   =  =======  ========================================================-
CD   1   1-2      45                                                      -
CD                                                                        -
CD   2   7-12     FUEL MANAGEMENT GROUP LABEL.                           -
CD                                                                        -
CD   3   13-18    REGION LABEL OR AREA LABEL FOR REGIONS CONTAINED IN    -
CD                THE FUEL MANAGEMENT GROUP DESIGNATED IN COLS. 7-12.    -
CD                                                                        -
CD   4   19-24    REGION LABEL OR AREA LABEL FOR REGIONS CONTAINED IN    -
CD                THE FUEL MANAGEMENT GROUP DESIGNATED IN COLS. 7-12.    -
CD                                                                        -
CD   5   25-30    REGION LABEL OR AREA LABEL FOR REGIONS CONTAINED IN    -
CD                THE FUEL MANAGEMENT GROUP DESIGNATED IN COLS. 7-12.    -
```

56

```
CD                                                                       -
CD   6   31-36   REGION LABEL OR AREA LABEL FOR REGIONS CONTAINED IN      -
CD               THE FUEL MANAGEMENT GROUP DESIGNATED IN COLS. 7-12.      -
CD                                                                       -
CD   7   37-42   REGION LABEL OR AREA LABEL FOR REGIONS CONTAINED IN      -
CD               THE FUEL MANAGEMENT GROUP DESIGNATED IN COLS. 7-12.      -
CD                                                                       -
CD   8   43-48   REGION LABEL OR AREA LABEL FOR REGIONS CONTAINED IN      -
CD               THE FUEL MANAGEMENT GROUP DESIGNATED IN COLS. 7-12.      -
CD                                                                       -
CD   9   49-54   REGION LABEL OR AREA LABEL FOR REGIONS CONTAINED IN      -
CD               THE FUEL MANAGEMENT GROUP DESIGNATED IN COLS. 7-12.      -
CD                                                                       -
CD  10   55-60   REGION LABEL OR AREA LABEL FOR REGIONS CONTAINED IN      -
CD               THE FUEL MANAGEMENT GROUP DESIGNATED IN COLS. 7-12.      -
CD                                                                       -
CD  11   61-66   REGION LABEL OR AREA LABEL FOR REGIONS CONTAINED IN      -
CD               THE FUEL MANAGEMENT GROUP DESIGNATED IN COLS. 7-12.      -
CD                                                                       -
CD  12   67-72   REGION LABEL OR AREA LABEL FOR REGIONS CONTAINED IN      -
CD               THE FUEL MANAGEMENT GROUP DESIGNATED IN COLS. 7-12.      -
C                                                                        -
CN               THE TYPE 45 CARDS PERMIT REDUCING THE NUMBER OF CARDS    -
CN               OF TYPE 11 OR 35 REQUIRED TO SPECIFY THE FUEL            -
CN               MANAGEMENT PATHS.  THIS IS PARTICULARY TRUE FOR 3D       -
CN               PROBLEMS WHERE TYPICALLY  ALL OF THE AXIAL REGIONS       -
CN               IN A FUEL ASSEMBLY WOULD BE TREATED TOGETHER AS FAR AS   -
CN               THE FUEL MANAGEMENT IS CONCERNED.                        -
CN                                                                       -
CN               TYPE 45 CARDS INDICATE THE REGIONS WHICH WILL BE         -
CN               TREATED COLLECTIVELY DURING FUEL MANAGEMENT PATHS AS     -
CN               AS SPECIFIED ON THE TYPE 11 OR TYPE 35 CARDS.  IF A      -
CN               FUEL MANAGEMENT GROUP LABEL IS SPECIFIED ON A TYPE 11    -
CN               OR 35 CARD, ALL OF THE ASSOCIATED REGIONS WILL BE        -
CN               ASSIGNED THE CORRESPONDING FUEL MATERIAL FOR THE         -
CN               INDICATED STAGE OF THE PATH INVOLVED.                    -
CN                                                                       -
CN               COLS. 7-12 AND 13-18 MAY NOT BE BLANK.                   -
CN                                                                       -
CN               THE REGIONS CORRESPONDING TO A GIVEN FUEL MANAGEMENT     -
CN               GROUP MUST BE UNIQUE.  THAT IS, REGION LABELS MAY NOT    -
CN               BE REPEATED IN COLS 13-72 FOR A GIVEN FUEL MANAGEMENT    -
CN               GROUP AND THE REGIONS IMPLIED BY AREA LABELS MAY NOT BE- -
CN               REPEATED FOR A GIVEN FUEL MANAGEMENT GROUP.              -
CN                                                                       -
CN               IF A BLANK FIELD IS ENCOUNTERED IN COLS. 13-18,          -
CN               19-24, 25-30, 31-36, 37-42, 43-48, 49-54, 55-60,         -
CN               61-66, OR 67-72, THE REST OF THE DATA ON THAT TYPE 45    -
CN               CARD WILL BE IGNORED.                                    -
C                                                                        -
C------------------------------------------------------------------------


C------------------------------------------------------------------------
CR            BURNUP DEPENDENT FITTING ISOTXS LABELS (TYPE 46)           -
C                                                                        -
CL      FORMAT-----(I2,4X,A6,2(A6,2E12.5))                               -
C                                                                        -
CD   #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY                -
CD   =  =======   =======================================================-
CD   1   1-2     46                                                      -
CD                                                                       -
CD   2   7-12    LABEL OF BURNUP DEPENDENT ISOTOPE WHOSE BURNUP DEPENDS  -
CD               ON THE ATOM DENSITY OF THE LABEL IN FIELDS 3.           -
CD                                                                       -
CD   3   13-18   LABEL OF THE ISOTOPE WHOSE ATOM DENSITY DETERMINES      -
CD               CROSS SECTIONS FOR ISOTOPE IN FIELD 2.                  -
CD                                                                       -
CD   6   25-30   SAME AS FIELD 2.                                        -
CD                                                                       -
CD   5   31-36   SAME AS FIELD 3.                                        -
```

```
CD                                                                      -
CD  6   43-48   SAME AS FIELD 2.                                        -
CD                                                                      -
CD  7   49-54   SAME AS FIELD 3.                                        -
CD                                                                      -
CD  8   61-66   SAME AS FIELD 2.                                        -
CD                                                                      -
CD  7   67-72   SAME AS FIELD 3.                                        -
CD                                                                      -
C                                                                       -
CN              USE OF THIS CARD IS ONLY NEEDED IF ONE ISOTOPE IS       -
CN              BURNED IN REFERENCE TO A DIFFERENT ISOTOPE, AND THE     -
CN              USER WISHES TO USE ATOM DENSITY INFORMATION FROM THE    -
CN              CROSS SECTION FILE ISOTXS, RATHER THAN SUPPLY           -
CN              REFERENCE BASE ISOTOPE ATOM DENSITY DATA ON CARD TYPE   -
CN              41 FIELDS #4 OR #7. NOTE THAT IF A.BURN IS UNFORMATTED,-
CN              THE USER MUST INSERT AT LEAST A DECIMAL POINT IN THESE -
CN              FIELDS IN ORDER TO PROCESS CARD TYPE 41 CORRECTLY. THE -
CN              PRESENCE OF "ZERO" IN THESE FIELDS CAUSES THE POLYFI    -
CN              MODULE TO LOOK FOR CARD TYPES 46, AND TO EXTRACT THE    -
CN              PARAMETER ADENS FROM THE 4D RECORD OF DATA SET ISOTXS   -
CN              TO BE USED INSTEAD.                                     -
C                                                                       -
C-----------------------------------------------------------------------
CEOF
```

```
C**********************************************************************
C                                                                    -
C                        Latest version 10/31/00                     -
C                        Current version 1.4 extracted 01/08/21       -
C                                                                    -
CF            A.DIF3D                                                 -
CE           ONE-, TWO-, AND THREE-DIMENSIONAL DIFFUSION THEORY      -
CE           MODULE-DEPENDENT BCD INPUT                              -
C                                                                    -
CN                        THIS BCD DATASET MAY BE WRITTEN EITHER     -
CN                        IN FREE FORMAT (UNFORM=A.DIF3D) OR         -
CN                        ACCORDING TO THE FORMATS SPECIFIED FOR EACH -
CN                        CARD TYPE (DATASET=A.DIF3D).               -
CN                                                                   -
CN                        COLUMNS 1-2 MUST CONTAIN THE CARD TYPE NUMBER. -
CN                                                                   -
CN                        A BLANK OR ZERO FIELD GIVES THE DEFAULT OPTION -
CN                        INDICATED.                                 -
CN                                                                   -
CN                        NON-DEFAULTED DATA ITEMS ON THE A.DIF3D    -
CN                        DATA SET ALWAYS OVERRIDE THE CORRESPONDING -
CN                        DATA ON THE RESTART DATA SET DIF3D.        -
C                                                                    -
CN                        THIS FILE DESCRIPTION IS FOR DIF3D/VARIANT 9.0 -
C                                                                    -
C**********************************************************************
C---------------------------------------------------------------------
CR            PROBLEM TITLE (TYPE 01)                                -
C                                                                    -
CL      FORMAT-----(I2,4X,11A6)                                      -
C                                                                    -
CD      COLUMNS          CONTENTS...IMPLICATIONS, IF ANY             -
CD      =======  ===========================================================-
CD       1-2      01                                                 -
CD                                                                   -
CD       7-72    ANY ALPHANUMERIC CHARACTERS (1 CARD ONLY).          -
C                                                                    -
C---------------------------------------------------------------------
C---------------------------------------------------------------------
CR            STORAGE AND DUMP SPECIFICATIONS (TYPE 02)              -
C                                                                    -
CL      FORMAT-----(I2,4X,3I6)                                       -
C                                                                    -
CD   #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY             -
CD   =  =======  ===========================================================-
CD   1  1-2      02                                                 -
CD                                                                   -
CD   2  7-12    POINTR CONTAINER ARRAY SIZE IN FAST CORE MEMORY (FCM) -
CD             IN REAL*8 WORDS (DEFAULT=10000).                      -
CD                                                                   -
CD   3  13-18   POINTR CONTAINER ARRAY SIZE IN EXTENDED CORE        -
CD             MEMORY (ECM) IN REAL*8 WORDS (DEFAULT=30000).         -
CD                                                                   -
CD   4  19-24   POINTR DEBUGGING EDIT.                              -
CD             0...NO DEBUGGING PRINTOUT (DEFAULT).                  -
CD             1...DEBUGGING DUMP PRINTOUT.                          -
CD             2...DEBUGGING TRACE PRINTOUT.                         -
CD             3...BOTH DUMP AND TRACE PRINTOUT.                     -
C                                                                    -
C---------------------------------------------------------------------
C---------------------------------------------------------------------
CR            PROBLEM CONTROL PARAMETERS (TYPE 03)                   -
C                                                                    -
CL      FORMAT-----(I2,4X,11I6)                                      -
C                                                                    -
CD   #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY             -
CD   =  =======  ===========================================================-
CD   1  1-2      03                                                 -
CD                                                                   -
CD   2  7-12    PROBLEM TYPE.                                        -
CD             0...K-EFFECTIVE PROBLEM (DEFAULT).                    -
CD             1...FIXED SOURCE PROBLEM.                             -
```

```
CD                                                                      -
CD   3   13-18   SOLUTION TYPE.                                          -
CD                  0...REAL SOLUTION (DEFAULT).                         -
CD                  1...ADJOINT SOLUTION.                                -
CD                  2...BOTH REAL AND ADJOINT SOLUTION.                  -
CD                                                                      -
CD   4   19-24   CHEBYSHEV ACCELERATION OF OUTER ITERATIONS.            -
CD                  0...YES, ACCELERATE THE OUTER ITERATIONS (DEFAULT). -
CD                  1...NO ACCELERATION.                                -
CD                                                                      -
CD   5   25-30   MINIMUM PLANE-BLOCK (RECORD) SIZE IN REAL*8 WORDS FOR  -
CD                  I/O TRANSFER IN THE CONCURRENT INNER ITERATION      -
CD                  STRATEGY. THE DEFAULT (=4500) IS HIGHLY RECOMMENDED.-
CD                                                                      -
CD   6   31-36   OUTER ITERATION CONTROL.                               -
CD                  -3...BYPASS DIF3D MODULE.                           -
CD                  -2...CALCULATE DATA MANAGEMENT PARAMETERS AND PERFORM -
CD                       NEUTRONICS EDITS ONLY.                         -
CD                  -1...CALCULATE DATA MANAGEMENT PARAMETERS, CALCULATE -
CD                       OVERRELAXATION FACTORS AND PERFORM NEUTRONICS  -
CD                       EDITS ONLY.                                    -
CD              .GE.0...MAXIMUM NUMBER OF OUTER ITERATIONS (DEFAULT=30). -
CD                                                                      -
CD   7   37-42   RESTART FLAG.                                          -
CD                  0...THIS IS NOT A RESTART (DEFAULT).                -
CD                  1...THIS IS A RESTART PROBLEM.                      -
CD                                                                      -
CD   8   43-48   JOB TIME LIMIT, MAXIMUM (CP AND PP(OR WAIT)) PROCESSOR -
CD                  SECONDS (DEFAULT=1000000000).                       -
CD                                                                      -
CD   9   49-54   NUMBER OF UPSCATTER ITERATIONS PER OUTER ITERATION     -
CD                  (DEFAULT=5).  PERTINENT TO UPSCATTER PROBLEMS ONLY. -
CD                                                                      -
CD  10   55-60   CONCURRENT ITERATION EFFICIENCY OPTION.                -
CD                  0...PERFORM THE ESTIMATED NO. OF INNER ITERATIONS FOR -
CD                       EACH GROUP.                                    -
CD                  1...AVOID THE LAST PASS OF INNER ITERATIONS IN THOSE -
CD                       GROUPS FOR WHICH THE NO. OF ITERATIONS IN THE LAST -
CD                       PASS ARE LESS THAN A CODE DEPENDENT THRESHOLD. -
CD                                                                      -
CD  11   61-66   ACCELERATION OF OPTIMUM OVERRELAXATION FACTOR          -
CD                  CALCULATION.                                        -
CD                  0...NO ACCELERATION (DEFAULT).                      -
CD                  1...ASYMPTOTIC SOURCE EXTRAPOLATION OF POWER ITERATIONS- 
CD                       USED TO ESTIMATE THE SPECTRAL RADIUS OF EACH INNER - 
CD                       (WITHIN GROUP) ITERATION MATRIX.               -
CD  12   67-72   OPTIMUM OVERRELAXATION FACTOR ESTIMATION ITERATION     -
CD                  CONTROL. THE DEFAULT (=50) IS STRONGLY RECOMMENDED. -
C                                                                       -
CN                  THE MAXIMUM NUMBER OF OUTER ITERATIONS SENTINEL     -
CN                  SPECIFIES THE NUMBER OF OUTERS THAT CAN BE PERFORMED -
CN                  (COLS. 31-36) EACH TIME THE DIF3D MODULE IS INVOKED. -
CN                                                                      -
CN                  THE DIF3D TERMINATION PROCEDURE WILL ALWAYS:        -
CN                       1...(RE)WRITE THE APPROPRIATE FLUX FILES       -
CN                          (RTFLUX OR ATFLUX).                         -
CN                       2...(RE)WRITE THE RESTART FILE DIF3D.          -
CN                  TO FACILITATE AUTOMATIC RESTART, THE RESTART FLAG   -
CN                  ON THE DIF3D RESTART CONTROL FILE WILL BE TURNED ON -
CN                  AUTOMATICALLY UPON DETECTION OF:                    -
CN                       1...MAXIMUM NUMBER OF OUTER ITERATIONS.        -
CN                       2...TIME LIMIT.                                -
CN                                                                      -
CN                                                                      -
CN                  TO RESTART THE FLUX CALCULATION:                    -
CN                  EITHER                                              -
CN                                                                      -
CN                      PROVIDE THE RESTART DATA SET DIF3D AND          -
CN                      THE APPROPRIATE FLUX DATA SET (RTFLUX OR ATFLUX) -
CN                      AND SPECIFY THEM UNDER "BLOCK=OLD" IN THE BCD   -
CN                      INPUT DATA                                      -
CN                  OR                                                  -
```

60

```
CN                         1...SET THE RESTART FLAG (COLS. 37-42) TO 1 ON    -
CN                            THE TYPE 03 CARD. THIS PERMITS IMMEDIATE       -
CN                            RESUMPTION OF OUTER ITERATION ACCELERATION.    -
CN                         2...INCLUDE THE LATEST K-EFFECTIVE ESTIMATE       -
CN                            (COLS. 13-24) AND THE DOMINANCE RATIO          -
CN                            ESTIMATE ON THE TYPE 06 CARD (COLS. 61-72).    -
CN                         3...INCLUDE THE OPTIMUM OVERRELAXATION FACTORS     -
CN                            FOR EACH GROUP (TYPE 07 CARD)                  -
CN                         4...PROVIDE THE APPROPRIATE FLUX DATA SET (RTFLUX -
CN                            OR ATFLUX) AND SPECIFY IT UNDER "BLOCK=OLD"     -
CN                            IN THE BCD INPUT DATA.                         -
CN                                                                          -
CN              A NON-ZERO TIME LIMIT (COLS. 43-48) OVERRIDES               -
CN              THE ACTUAL TIME LIMIT DETERMINED INTERNALLY                 -
CN              BY SYSTEM ROUTINES IN THE ANL AND LBL PRODUCTION            -
CN              IMPLEMENTATIONS                                             -
CN                                                                          -
CN              THE TIME LIMIT PARAMETER (COLS. 43-48) IS PERTINENT         -
CN              TO EACH ENTRY TO THE DIF3D MODULE.                          -
CN                                                                          -
CN              IT IS RECOMMENDED THAT AN ODD NUMBER OF UPSCATTER           -
CN              ITERATIONS BE SPECIFIED (COLS. 49-54) TO AVOID              -
CN              ADDITIONAL I/O OVERHEAD.                                    -
CN                                                                          -
CN              THE USER IS CAUTIONED TO MONITOR THE POINT-WISE             -
CN              FISSION SOURCE CONVERGENCE TO ENSURE THAT MONOTONIC         -
CN              CONVERGENCE IS OBTAINED WHEN THE EFFICIENCY OPTION          -
CN              (COLS. 55-60) IS ACTIVATED.                                 -
CN                                                                          -
CN              THE OPTIMUM OVERRELAXATION FACTOR ACCELERATION OPTION       -
CN              IS PRIMARILY INTENDED FOR PROBLEMS KNOWN TO HAVE HIGH       -
CN              (>1.8) OPTIMUM OVERRELAXATION FACTORS.                      -
CN                                                                          -
CN              ITERATION CONTROL (COLS. 67-72) OF THE OPTIMUM             -
CN              OVERRELAXATION FACTOR ESTIMATION IS PRIMARILY INTENDED -
CN              FOR USE IN CONJUNCTION WITH THE ASYMPTOTIC ACCELERATION-
CN              OPTION (COLS. 61-66).                                       -
C                                                                          -
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
CR            EDIT OPTIONS (TYPE 04)                                        -
C                                                                          -
CL    FORMAT-----(I2,4X,10I6)                                              -
C                                                                          -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY                   -
CD  =  =======  ========================================================-
CD  1  1-2      04                                                        -
CD                                                                        -
CD  2  7-12     PROBLEM DESCRIPTION EDIT (IN ADDITION TO USER INPUT       -
CD              SPECIFICATIONS WHICH ARE ALWAYS EDITED.                    -
CD              0...NO EDITS (DEFAULT).                                    -
CD              1...PRINT EDITS.                                           -
CD              2...WRITE EDITS TO AUXILIARY OUTPUT FILE.                  -
CD              3...WRITE EDITS TO BOTH PRINT AND AUXILIARY OUTPUT FILE-
CD                                                                        -
CD  3  13-18    GEOMETRY (REGION TO MESH INTERVAL) MAP EDIT.              -
CD              0...NO EDITS (DEFAULT).                                    -
CD              1...PRINT EDITS.                                           -
CD              2...WRITE EDITS TO AUXILIARY OUTPUT FILE.                  -
CD              3...WRITE EDITS TO BOTH PRINT AND AUXILIARY OUTPUT FILE-
CD                                                                        -
CD  4  19-24    GEOMETRY (ZONE TO MESH INTERVAL) MAP EDIT.                -
CD              0...NO EDITS (DEFAULT).                                    -
CD              1...PRINT EDITS.                                           -
CD              2...WRITE EDITS TO AUXILIARY OUTPUT FILE.                  -
CD              3...WRITE EDITS TO BOTH PRINT AND AUXILIARY OUTPUT FILE-
CD                                                                        -
CD  5  25-30    MACROSCOPIC CROSS SECTION EDIT.                           -
CD              ENTER TWO DIGIT NUMBER SP WHERE                           -
CD                                                                        -
CD              S CONTROLS THE SCATTERING AND PRINCIPAL CROSS SECTIONS -
CD              P CONTROLS THE PRINCIPAL CROSS SECTIONS EDIT ONLY.        -
```

```
CD                                                                  -
CD                THE INTEGERS S AND P SHOULD BE ASSIGNED ONE OF THE -
CD                FOLLOWING VALUES (LEADING ZEROES ARE IRRELEVANT).  -
CD                0...NO EDITS (DEFAULT).                            -
CD                1...PRINT EDITS.                                   -
CD                2...WRITE EDITS TO AUXILIARY OUTPUT FILE.          -
CD                3...WRITE EDITS TO BOTH PRINT AND AUXILIARY OUTPUT FILE-
CD                                                                  -
CD  6   31-36    BALANCE EDITS                                       -
CD                ENTER 3 DIGIT NUMBER GBR WHERE                     -
CD                                                                  -
CD                G CONTROLS GROUP BALANCE EDITS INTEGRATED OVER THE -
CD                REACTOR                                            -
CD                B CONTROLS REGION BALANCE EDIT BY GROUP            -
CD                R CONTROLS REGION BALANCE EDIT TOTALS              -
CD                   (INCLUDING NET PRODUCTION AND ENERGY MEDIANS)   -
CD                                                                  -
CD                THE INTEGERS G, B, AND R SHOULD BE ASSIGNED ONE OF THE -
CD                FOLLOWING VALUES (LEADING ZEROES ARE IRRELEVANT)   -
CD                0...NO EDITS (DEFAULT).                            -
CD                1...PRINT EDITS.                                   -
CD                2...WRITE EDITS TO AUXILIARY OUTPUT FILE.          -
CD                3...WRITE EDITS TO BOTH PRINT AND AUXILIARY OUTPUT FILE-
CD                                                                  -
CD  7   37-42    POWER EDITS                                         -
CD                ENTER 2 DIGIT NUMBER RM WHERE                      -
CD                                                                  -
CD                R CONTROLS REGION POWER AND AVERAGE POWER DENSITY EDITS-
CD                M CONTROLS POWER DENSITY BY MESH INTERVAL EDIT (PWDINT)-
CD                                                                  -
CD                THE INTEGERS R AND M SHOULD BE ASSIGNED            -
CD                ONE OF THE FOLLOWING VALUES (LEADING ZEROES ARE    -
CD                IRRELEVANT)                                        -
CD                0...NO EDITS (DEFAULT).                            -
CD                1...PRINT EDITS.                                   -
CD                2...WRITE EDITS TO AUXILIARY OUTPUT FILE.          -
CD                3...WRITE EDITS TO BOTH PRINT AND AUXILIARY OUTPUT FILE-
CD                                                                  -
CD  8   43-48    FLUX EDITS                                          -
CD                ENTER 3 DIGIT INTEGER RMB WHERE                    -
CD                                                                  -
CD                R CONTROLS FLUX EDIT BY REGION AND GROUP           -
CD                   INCLUDING GROUP AND REGION TOTALS               -
CD                M CONTROLS TOTAL (GROUP INTEGRATED) FLUX EDIT      -
CD                   BY MESH INTERVAL                                -
CD                B CONTROLS TOTAL FLUX EDIT BY MESH INTERVAL AND GROUP -
CD                   (RTFLUX OR ATFLUX)                              -
CD                                                                  -
CD                THE INTEGERS R, M, AND B SHOULD BE ASSIGNED        -
CD                ONE OF THE FOLLOWING VALUES (LEADING ZEROES ARE    -
CD                IRRELEVANT)                                        -
CD                0...NO EDITS (DEFAULT).                            -
CD                1...PRINT EDITS.                                   -
CD                2...WRITE EDITS TO AUXILIARY OUTPUT FILE.          -
CD                3...WRITE EDITS TO BOTH PRINT AND AUXILIARY OUTPUT FILE-
CD                                                                  -
CD  9   49-54    ZONE AVERAGED (REAL) FLUX EDIT.                     -
CD                0...NO EDITS (DEFAULT).                            -
CD                1...PRINT EDITS.                                   -
CD                2...WRITE EDITS TO AUXILIARY OUTPUT FILE.          -
CD                3...WRITE EDITS TO BOTH PRINT AND AUXILIARY OUTPUT FILE-
CD                                                                  -
CD 10   55-60    REGION AVERAGED FLUX EDIT.                          -
CD                0...NO EDITS (DEFAULT).                            -
CD                1...PRINT EDITS.                                   -
CD                2...WRITE EDITS TO AUXILIARY OUTPUT FILE.          -
CD                3...WRITE EDITS TO BOTH PRINT AND AUXILIARY OUTPUT FILE-
CD                                                                  -
CD 11   61-66    INTERFACE FILES TO BE WRITTEN IN ADDITION TO RTFLUX -
CD                AND/OR ATFLUX.                                     -
CD                ENTER 4 DIGIT INTEGER FSRP WHERE                   -
CD                                                                  -
```

```
CD              F CONTROLS WRITING OF SURFACE FAST FLUX TO SFEDIT    -
CD              S CONTROLS WRITING OF SURFACE POWER DENSITY TO SFEDIT -
CD              R CONTROLS WRITING OF RZFLUX                          -
CD              P CONTROLS WRITING OF PWDINT                          -
CD                                                                   -
CD              THE INTEGERS F, S, R, AND P SHOULD BE ASSIGNED ONE OF -
CD              THE FOLLOWING VALUES (LEADING ZEROES ARE IRRELEVANT) -
CD              0...DO NOT WRITE THE INTERFACE FILE                  -
CD              1...WRITE THE INTERFACE FILE (SFEDIT WILL BE WRITTEN -
CD                  IN REGULAR MESH CELL ORDER)                      -
CD              2...WRITE THE SFEDIT FILE IN REGION ORDER (PERTINENT -
CD                  TO THE SFEDIT FILE ONLY)                         -
CD                                                                   -
CD  12  67-72   MASTER DIF3D EDIT SENTINEL DURING CRITICALITY SEARCHES -
CD              -1...SUPPRESS ALL DIF3D EDITS EXCEPT THE ITERATION   -
CD                   HISTORY AND ERROR DIAGNOSTICS                   -
CD              0...EDIT INPUT DATA ON 1ST SEARCH PASS, OUTPUT       -
CD                  INTEGRALS UPON CONVERGENCE OR UPON ACHIEVING THE -
CD                  MAXIMUM SEARCH PASS LIMIT.                       -
CD              N...ALSO INVOKE SPECIFIED DIF3D EDITS EVERY N-TH     -
CD                  SEARCH PASS.                                     -
C                                                                   -
CN              MULTI-DIGIT EDIT SPECIFICATION EXAMPLES.            -
CN                                                                   -
CN              ENTERING THE INTEGER 201 IN COLUMNS 31-36 YIELDS    -
CN              THE GROUP BALANCE EDIT ON THE AUXILIARY FILE AND    -
CN              THE REGION BALANCE EDIT ON THE PRIMARY PRINT FILE.  -
CN                                                                   -
CN              ENTERING THE INTEGER 30 IN COLUMNS 31-36 YIELDS     -
CN              THE REGION BALANCE EDIT BY GROUP ON BOTH THE PRINT AND -
CN              THE AUXILIARY OUTPUT FILES.                         -
CN                                                                   -
CN              THE INTERFACE FILE SFEDIT CONTAINS SURFACE- AND     -
CN              CELL-AVERAGED POWER DENSITY AND/OR FAST FLUX DATA   -
CN              BY MESH CELL.  ON OPTION IT IS WRITTEN IN EITHER    -
CN              STANDARD FINE MESH CELL ORDER OR IN REGION ORDER.   -
C                                                                   -
C---------------------------------------------------------------------
C---------------------------------------------------------------------
CR          CONVERGENCE CRITERIA (TYPE 05)                          -
C                                                                   -
CL    FORMAT-----(I2,10X,3E12.5)                                    -
C                                                                   -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY             -
CD  =  =======  =========================================================-
CD  1  1-2      05                                                  -
CD                                                                   -
CD  2  13-24    EIGENVALUE CONVERGENCE CRITERION FOR STEADY STATE   -
CD              CALCULATION (DEFAULT VALUE = 1.0E-7 IS RECOMMENDED). -
CD                                                                   -
CD  3  25-36    POINTWISE FISSION SOURCE CONVERGENCE CRITERION      -
CD              FOR STEADY STATE SHAPE CALCULATION                  -
CD              (DEFAULT VALUE = 1.0E-5 IS RECOMMENDED).            -
CD                                                                   -
CD  4  37-48    AVERAGE FISSION SOURCE CONVERGENCE CRITERION        -
CD              FOR STEADY STATE SHAPE CALCULATION                  -
CD              (DEFAULT VALUE = 1.0E-5 IS RECOMMENDED).            -
C                                                                   -
CN              IN UPSCATTERING PROBLEMS IT IS RECOMMENDED THAT     -
CN              THE EIGENVALUE CONVERGENCE CRITERION (COLS. 13-24)  -
CN              BE .1 TIMES THE POINTWISE FISSION SOURCE CONVERGENCE -
CN              CRITERION (COLS. 25-36).                            -
C                                                                   -
C---------------------------------------------------------------------
C---------------------------------------------------------------------
CR          OTHER FLOATING POINT DATA (TYPE 06)                     -
C                                                                   -
CL    FORMAT-----(I2,10X,5E12.5)                                    -
C                                                                   -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY             -
CD  =  =======  =========================================================-
CD  1  1-2      06                                                  -
```

```
CD                                                                         -
CD  2  13-24   K-EFFECTIVE OF REACTOR (DEFAULT IS OBTAINED FROM            -
CD            THE APPROPRIATE RTFLUX OR ATFLUX FILE, IF PRESENT.          -
CD            OTHERWISE DEFAULT = 1.0).                                    -
CD                                                                         -
CD  3  25-36   ANY POINTWISE FISSION SOURCE WILL BE NEGLECTED IN THE       -
CD            POINTWISE FISSION SOURCE CONVERGENCE TEST IF IT IS          -
CD            LESS THAN THIS FACTOR TIMES THE R.M.S. FISSION              -
CD            SOURCE (DEFAULT VALUE = .001 IS RECOMMENDED).               -
CD                                                                         -
CD  4  37-48   ERROR REDUCTION FACTOR TO BE ACHIEVED BY EACH SERIES        -
CD            OF INNER ITERATIONS FOR EACH GROUP DURING A SHAPE           -
CD            CALCULATION - STRONGLY RECOMMENDED THAT THE DEFAULT         -
CD            VALUE OF (.04) BE USED.                                     -
CD                                                                         -
CD  5  49-60   STEADY STATE REACTOR POWER (WATTS). (DEFAULT = 1.0).        -
CD                                                                         -
CD  6  61-72   DOMINANCE RATIO (FOR RESTART JOBS ONLY).                    -
C                                                                          -
CN            K-EFFECTIVE SPECIFICATIONS (COLS. 13-24):                   -
CN                 1...FOR K-EFFECTIVE PROBLEMS, SUPPLY ESTIMATED         -
CN                      K-EFFECTIVE OF REACTOR.                           -
CN                 2...FOR RESTARTED K-EFFECTIVE PROBLEMS, SUPPLY         -
CN                      LATEST K-EFFECTIVE ESTIMATE SUPPLIED ON THE       -
CN                      ITERATION HISTORY EDIT.                           -
CN                 3...FOR SOURCE PROBLEMS, SUPPLY K-EFFECTIVE OF         -
CN                      THE REACTOR.                                      -
CN            DEFAULT IS OBTAINED FROM THE APPROPRIATE RTFLUX OR          -
CN            ATFLUX FILE, IF PRESENT.  OTHERWISE DEFAULT=1.0 .           -
C                                                                          -
CN            NON-MONOTONIC POINTWISE FISSION SOURCE CONVERGENCE          -
CN            IS USUALLY INDICATIVE OF THE NEED TO TIGHTEN THE ERROR -
CN            REDUCTION FACTOR(COLS. 37-48).  THIS IS FREQUENTLY TRUE-
CN            IN TRIANGULAR GEOMETRY PROBLEMS WHERE A VALUE OF .01 IS-
CN            USUALLY SUFFICIENT TO OBTAIN MONOTONIC CONVERGENCE.    -
C-------------------------------------------------------------------------
C-------------------------------------------------------------------------
CR           OPTIMUM OVERRELAXATION FACTORS (TYPE 07)                     -
C                                                                          -
CL    FORMAT-----(I2,10X,5E12.5)                                          -
C                                                                          -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY                   -
CD  =  =======  =========================================================-
CD  1  1-2      07                                                        -
CD                                                                         -
CD  2  13-24    OPTIMUM OVERRELAXATION FACTOR FOR GROUP 1.                -
CD                                                                         -
CD  3  25-36    OPTIMUM OVERRELAXATION FACTOR FOR GROUP 2.                -
CD                                                                         -
CD  4  37-48    OPTIMUM OVERRELAXATION FACTOR FOR GROUP 3.                -
CD                                                                         -
CD  5  49-60    OPTIMUM OVERRELAXATION FACTOR FOR GROUP 4.                -
CD                                                                         -
CD  6  61-72    OPTIMUM OVERRELAXATION FACTOR FOR GROUP 5.                -
C                                                                          -
CN            REPEAT 5 VALUES PER CARD FOR AS MANY TYPE 07 CARDS          -
CN            AS ARE NEEDED.                                              -
CN                                                                         -
CN            THE OPTIMUM OVERRELAXATION FACTORS ARE NORMALLY             -
CN            OBTAINED FROM THE RESTART INSTRUCTIONS PRINTED              -
CN            IMMEDIATELY AFTER THE DIF3D ITERATION HISTORY EDIT.         -
CN            IN THE RESTART INSTRUCTIONS, THE FACTORS ARE ALWAYS         -
CN            EDITED IN THE --REAL PROBLEM-- ORDERING AND SHOULD BE -
CN            ENTERED ON THE TYPE 07 CARD --EXACTLY-- AS EDITED          -
CN            IN THE RESTART INSTRUCTIONS.                                -
CN                                                                         -
CN            THE PERMISSIBLE FACTOR RANGE IS BOUNDED BY 1.0 AND 2.0 -
CN            INCLUSIVE. A ZERO OR BLANK FACTOR ENTRY DEFAULTS           -
CN            TO 1.0. FACTORS ARE COMPUTED FOR THOSE GROUPS HAVING       -
CN            A FACTOR OF 1.0; FACTORS GREATER THAN 1.0 ARE NOT          -
CN            RECOMPUTED.                                                 -
CN                                                                         -
```

```
CN                   TYPE 07 CARDS ARE PRIMARILY INTENDED FOR RESTART JOBS   -
CN                   ONLY (STRONGLY RECOMMENDED).                            -
C                                                                            -
C----------------------------------------------------------------------------
C----------------------------------------------------------------------------
CR           NEAR CRITICAL SOURCE PROBLEM ASYMPTOTIC EXTRAPOLATION          -
CR           PARAMETERS (TYPE 08)                                           -
C                                                                            -
CC           ***** WARNING...SELECT THIS OPTION ONLY IF THE   *****         -
CC           ***** ASYMPTOTIC EXTRAPOLATION IS REQUIRED FOR   *****         -
CC           ***** THIS PROBLEM.                              *****         -
C                                                                            -
CL    FORMAT-----(I2,4X,I6,E12.5,I6)                                        -
C                                                                            -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY                     -
CD  =  =======  ========================================================== -
CD  1  1-2      08                                                          -
CD                                                                          -
CD  2  7-12     NUMBER OF OUTER (POWER) ITERATIONS PERFORMED PRIOR TO       -
CD             ASYMPTOTIC EXTRAPOLATION OF NEAR CRITICAL SOURCE             -
CD             PROBLEM (DEFAULT=5).                                         -
CD                                                                          -
CD  3  13-24    EIGENVALUE OF THE HOMOGENEOUS PROBLEM CORRESPONDING         -
CD             TO THE NEAR CRITICAL SOURCE PROBLEM. THIS EIGENVALUE         -
CD             MUST BE LESS THAN ONE.                                       -
CD                                                                          -
CD  4  25-30    INITIAL FLUX GUESS SENTINEL.                                -
CD             0...FLAT FLUX GUESS=1.0 (DEFAULT)                            -
CD             1...FLAT FLUX GUESS=0.0                                      -
C                                                                            -
CN            THE TYPE 08 CARD IS REQUIRED TO ACTIVATE AN ALTERNATE         -
CN            SPECIAL ACCELERATION SCHEME FOR NEAR CRITICAL                 -
CN            SOURCE PROBLEMS.                                              -
CN                                                                          -
CN            IF COLS. 13-24 ARE ZERO OR BLANK, THE HOMOGENEOUS            -
CN            PROBLEM EIGENVALUE WILL BE ESTIMATED. IN THIS CASE, IT        -
CN            IS RECOMMENDED TO INCREASE THE NUMBER OF ITERATIONS IN        -
CN            COLS. 7-12 TO AT LEAST 10.                                    -
C                                                                            -
C----------------------------------------------------------------------------
C----------------------------------------------------------------------------
CR           SN TRANSPORT OPTIONS (TYPE 09)                                 -
C                                                                            -
CL    FORMAT-----(I2,4X,2I6,6X,E12.4)                                       -
C                                                                            -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY                     -
CD  =  =======  ==========================================================-
CD  1  1-2      09                                                          -
CD                                                                          -
CD  2  7-12     SN ORDER.                                                   -
CD                                                                          -
CD  3  13-18    MAXIMUM ALLOWED NUMBER OF LINE SWEEPS PER LINE PER          -
CD             INNER ITERATION (DEFAULT=10).                                -
CD                                                                          -
CD  4  25-36    LINE SWEEP CONVERGENCE CRITERION (DEFAULT=1.0E-4).          -
C                                                                            -
CN            TO INVOKE THE DIF3D TRANSPORT OPTION, THE TYPE 09 CARD        -
CN            MUST BE PRESENT WITH A NONZERO SN ORDER. FOR THE TIME         -
CN            BEING, USERS MUST ALSO CONTINUE TO 'PRELIB' TO                -
CN            DATASET 'C116.B99983.MODLIB' TO INVOKE THIS OPTION.           -
C                                                                            -
C----------------------------------------------------------------------------
C----------------------------------------------------------------------------
CR           PARAMETERS FOR NODAL OPTION (TYPE 10)                          -
C                                                                            -
CL    FORMAT-----(I2,4X,7I6)                                                -
C                                                                            -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY                     -
CD  =  =======  ==========================================================-
CD  1  1-2      10                                                          -
CD                                                                          -
CD  2  7-12     NODAL APPROXIMATION IN XY-PLANE.                            -
```

65

```
CD                      ENTER 3 DIGIT NUMBER LMN WHERE               -
CD                                                                   -
CD                      L DETERMINES WHETHER THIS IS A DIFFUSION OR TRANSPORT -
CD                        CALCULATION.                               -
CD                      M IS THE ORDER OF THE POLYNOMIAL APPROXIMATION TO THE -
CD                        ONE-DIMENSIONAL FLUXES IN THE XY-PLANE.    -
CD                      N IS THE ORDER OF THE POLYNOMIAL APPROXIMATION TO THE -
CD                        LEAKAGES TRANSVERSE TO THE X- AND Y-DIRECTIONS. -
CD                                                                   -
CD                      HEXAGONAL GEOMETRY:                          -
CD                      L = 0...(ALWAYS - ONLY DIFFUSION THEORY IS AVAILABLE -
CD                              IN HEXAGONAL GEOMETRY).              -
CD                      M = 2...NH2 FLUX APPROXIMATION.              -
CD                      M = 3...NH3 FLUX APPROXIMATION.              -
CD                      M = 4...NH4 FLUX APPROXIMATION (DEFAULT).    -
CD                      N = 0...(ALWAYS).                            -
CD                                                                   -
CD                      CARTESIAN GEOMETRY:                          -
CD                      L = 0...DIFFUSION-THEORY OPTION (DEFAULT).   -
CD                      L = 1...TRANSPORT-THEORY OPTION.             -
CD                      M = 2...NX2 (QUADRATIC) FLUX APPROXIMATION.  -
CD                      M = 3...NX3 (CUBIC    ) FLUX APPROXIMATION (DEFAULT). -
CD                      M = 4...NX4 (QUARTIC  ) FLUX APPROXIMATION.  -
CD                      N = 0...CONSTANT  LEAKAGE APPROXIMATION.     -
CD                      N = 2...QUADRATIC LEAKAGE APPROXIMATION (DEFAULT). -
CD                                                                   -
CD                      LEADING ZEROS ARE IRRELEVANT.               -
CD                      THEREFORE, DEFAULT VALUES FOR MN ARE 40 (HEXAGONAL -
CD                      GEOMETRY) AND 32 (CARTESIAN GEOMETRY).       -
CD                                                                   -
CD                      IF THE TRANSPORT OPTION (L=1) IS SPECIFIED, TRANSPORT -
CD                      THEORY IS USED IN BOTH THE XY-PLANE AND THE AXIAL -
CD                      DIRECTION IN THREE-DIMENSIONAL CARTESIAN GEOMETRY. -
CD                                                                   -
CD  3   13-18   NODAL APPROXIMATION IN Z-DIRECTION.                  -
CD                      ENTER 2 DIGIT NUMBER MN WHERE                -
CD                                                                   -
CD                      M IS THE ORDER OF THE POLYNOMIAL APPROXIMATION TO THE -
CD                        ONE-DIMENSIONAL FLUX IN THE Z-DIRECTION.   -
CD                      N IS THE ORDER OF THE POLYNOMIAL APPROXIMATION TO THE -
CD                        LEAKAGE TRANSVERSE TO THE Z-DIRECTION.     -
CD                                                                   -
CD                      HEXAGONAL AND CARTESIAN GEOMETRIES:          -
CD                      M = 2...NZ2 (QUADRATIC) FLUX APPROXIMATION.  -
CD                      M = 3...NZ3 (CUBIC    ) FLUX APPROXIMATION (DEFAULT). -
CD                      M = 4...NZ4 (QUARTIC  ) FLUX APPROXIMATION (CARTESIAN -
CD                              GEOMETRY ONLY).                      -
CD                      N = 0...CONSTANT  LEAKAGE APPROXIMATION.     -
CD                      N = 2...QUADRATIC LEAKAGE APPROXIMATION (DEFAULT). -
CD                                                                   -
CD                      LEADING ZEROS ARE IRRELEVANT.               -
CD                      THEREFORE, DEFAULT VALUE FOR MN IS 32.       -
CD                                                                   -
CD  4   19-24   COARSE-MESH REBALANCE ACCELERATION CONTROL.         -
CD                   -1...NO COARSE-MESH REBALANCE ACCELERATION.     -
CD               .GT.0...NUMBER OF FINE MESH PER REBALANCE MESH IN X- AND -
CD                       Y-DIRECTIONS - CARTESIAN GEOMETRY ONLY (DEFAULT=4).-
CD                                                                   -
CD  5   25-30   NUMBER OF XY-PLANE PARTIAL CURRENT SWEEPS PER GROUP  -
CD                      PER AXIAL MESH SWEEP PER OUTER ITERATION.    -
CD                      (DEFAULT = 0 - LET CODE DECIDE).             -
CD                                                                   -
CD  6   31-36   NUMBER OF AXIAL PARTIAL CURRENT SWEEPS PER GROUP     -
CD                      PER AXIAL PARTIAL CURRENT SWEEP              -
CD                      PER OUTER ITERATION (DEFAULT=2).             -
CD                                                                   -
CD  7   37-42   HALF-DOMAIN SYMMETRY FLAG.                          -
CD                   -1...DO NOT USE 30 DEGREE (HEXAGONAL GEOMETRY) OR 45 -
CD                        DEGREE (CARTESIAN GEOMETRY) PLANAR SYMMETRY EVEN -
CD                        IF SUCH SYMMETRY EXISTS.                   -
CD                    0...USE 30 DEGREE (HEXAGONAL GEOMETRY) OR 45 DEGREE -
CD                        (CARTESIAN GEOMETRY) PLANAR SYMMETRY IF SUCH -
```

```
CD                    SYMMETRY EXISTS (DEFAULT).                         -
C                                                                       -
CN                    THE NODAL OPTION IS INVOKED IN HEXAGONAL GEOMETRY BY  -
CN                    SPECIFYING GEOMETRY-TYPE SENTINELS BETWEEN 110 AND 128 -
CN                    ON THE A.NIP3 TYPE 03 CARD.                       -
CN                                                                       -
CD  8   43-48   ASYMPTOTIC SOURCE EXTRAPOLATION SENTINEL.               -
CD              0...PERFORM ASYMPTOTIC SOURCE EXTRAPOLATION ON THE      -
CD                   THE NODAL OUTER ITERATIONS.                        -
CD              1...DO NOT PERFORM ASYMPTOTIC SOURCE EXTRAPOLATION      -
CD                                                                      -
CN              THE NODAL OPTION IS INVOKED IN CARTESIAN GEOMETRY BY    -
CN              SPECIFYING GEOMETRY-TYPE SENTINELS 40 OR 44 ON THE      -
CN              A.NIP3 TYPE 03 CARD AND PROVIDING ANY ACCEPTABLE        -
CN              (E.G. DEFAULT) VALUES ON A.DIF3D TYPE 10 CARD.          -
CN                                                                      -
CN        *** THE CARTESIAN-GEOMETRY NODAL OPTION MAY NOT BE           -
CN            AVAILABLE IN ALL VERSIONS OF DIF3D. ***                  -
C                                                                      -
CN              IT IS IMPORTANT THAT THE NUMBER OF FINE MESH PER        -
CN              REBALANCE MESH BE CHOSEN SUCH THAT THE AVERAGE          -
CN              REBALANCE MESH SPACING IS APPROXIMATELY 30 TO 40 CM IN -
CN              THE XY-PLANE.  THUS, FOR EXAMPLE, IF THE AVERAGE FINE   -
CN              MESH SPACING IS DELTA CM, THEN THE INTEGER INPUT IN     -
CN              COLS. 19-24 SHOULD BE BETWEEN 30/DELTA AND 40/DELTA.    -
C                                                                      -
CN              IF SLOW (OR DIVERGENT) ITERATIVE CONVERGENCE BEHAVIOR   -
CN              IS OBSERVED, THE NUMBER OF PARTIAL CURRENT SWEEPS       -
CN              SPECIFIED IN COLS. 25-30 AND 31-36 SHOULD BE INCREASED.-
C                                                                      -
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
CR           AXIAL COARSE-MESH REBALANCE BOUNDARIES FOR NODAL          -
CR           OPTION (TYPE 11)                                          -
C                                                                      -
CL    FORMAT-----(I2,10X,3(I6,E12.5))                                  -
C                                                                      -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY              -
CD  =  =======  ========================================================-
CD  1  1-2     11                                                      -
CD                                                                     -
CD  2  13-18   NUMBER OF AXIAL COARSE-MESH REBALANCE INTERVALS.        -
CD                                                                     -
CD  3  19-30   UPPER Z-COORDINATE OF THE COARSE-MESH REBALANCE         -
CD             BOUNDARY.                                               -
CD                                                                     -
CD  4  31-36   NUMBER OF AXIAL COARSE-MESH REBALANCE INTERVALS.        -
CD                                                                     -
CD  5  37-48   UPPER Z-COORDINATE OF THE COARSE-MESH REBALANCE         -
CD             BOUNDARY.                                               -
CD                                                                     -
CD  6  49-54   NUMBER OF AXIAL COARSE-MESH REBALANCE INTERVALS.        -
CD                                                                     -
CD  7  55-66   UPPER Z-COORDINATE OF THE COARSE-MESH REBALANCE         -
CD             BOUNDARY.                                               -
C                                                                      -
CN              THE TYPE 11 CARD IS PERTINENT ONLY WHEN THE THREE-      -
CN              DIMENSIONAL NODAL OPTION (A.NIP3 TYPE 03 GEOMETRY-TYPE -
CN              SENTINEL VALUE EQUAL TO 44 OR BETWEEN 120 AND 128) IS   -
CN              SPECIFIED.                                              -
CN                                                                     -
CN              IF NO TYPE 11 CARDS ARE PRESENT, THE AXIAL COARSE-MESH -
CN              REBALANCE BOUNDARIES ARE DEFINED BY THE AXIAL COARSE-   -
CN              MESH BOUNDARIES OBTAINED FROM THE GEODST FILE.  THESE   -
CN              BOUNDARIES IN TURN ARE ANY BOUNDARY POSITIONS SPECIFIED-
CN              ON THE DATASET A.NIP3 TYPE 09 OR 30 CARDS.             -
CN                                                                     -
CN              AXIAL COARSE-MESH REBALANCE BOUNDARIES MUST BE SELECTED-
CN              FROM THE SET OF COARSE-MESH BOUNDARIES CONTAINED IN THE-
CN              GEODST FILE, AS DETERMINED BY THE COARSE-MESH          -
CN              BOUNDARIES WHICH ARE EXPLICITLY MENTIONED ON THE       -
CN              DATASET A.NIP TYPE 09 OR 30 CARDS.                     -
```

```
CN                                                                       -
CN                    BOUNDARIES ARE SPECIFIED VIA NUMBER PAIRS.         -
CN                    EACH NUMBER PAIR IS OF THE FORM (N(I), Z(I)). THERE -
CN                    ARE N(I) AXIAL COARSE-MESH REBALANCE INTERVALS BETWEEN -
CN                    Z(I-1) AND Z(I), WHERE Z(0) IS THE LOWER REACTOR    -
CN                    BOUNDARY IN THE Z-DIRECTION. NUMBER PAIRS MUST BE   -
CN                    GIVEN IN ORDER OF INCREASING MESH COORDINATES. ALL  -
CN                    AXIAL COARSE-MESH REBALANCE BOUNDARIES MUST COINCIDE -
CN                    WITH THE MESH LINES WHICH BOUND MESH INTERVALS.     -
C                                                                        -
C------------------------------------------------------------------------
C------------------------------------------------------------------------
CR            PARAMETERS FOR VARIATIONAL NODAL OPTION (TYPE 12)          -
C                                                                        -
CL     FORMAT-----(I2,4X,11I6)                                           -
C                                                                        -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY                -
CD  =  =======  ========================================================-
CD  1  1-2      12                                                       -
CD                                                                       -
CD  2  7-12     NODAL SPATIAL APPROXIMATION.                             -
CD              ENTER 3 DIGIT NUMBER LMN WHERE                           -
CD                                                                       -
CD              L IS THE ORDER OF THE POLYNOMIAL APPROXIMATION OF THE    -
CD                SOURCE WITHIN THE NODE.                                -
CD              M IS THE ORDER OF THE POLYNOMIAL APPROXIMATION OF THE    -
CD                FLUXES WITHIN THE NODE.                                -
CD              N IS THE ORDER OF THE POLYNOMIAL APPROXIMATION OF THE    -
CD                LEAKAGES ON THE SURFACES OF THE NODES.                 -
CD                                                                       -
CD              HEXAGONAL AND CARTESIAN GEOMETRY:                        -
CD              L = 1... LINEAR SOURCE APPROXIMATION.                    -
CD              L = 2... QUADRATIC SOURCE APPROXIMATION.                 -
CD              L = 3... CUBIC    SOURCE APPROXIMATION.                  -
CD              L = 4... QUARTIC   SOURCE APPROXIMATION.                 -
CD              L = 5... 5TH ORDER SOURCE APPROXIMATION.                 -
CD              L = 6... 6TH ORDER SOURCE APPROXIMATION.                 -
CD                  (DEFAULT VALUE L=N+1).                               -
CD                  (L CANNOT BE GREATER THAN M).                        -
CD              M = 1... LINEAR  FLUX  APPROXIMATION.                    -
CD              M = 2... QUADRATIC  FLUX  APPROXIMATION.                 -
CD              M = 3... CUBIC     FLUX  APPROXIMATION.                  -
CD              M = 4... QUARTIC   FLUX  APPROXIMATION (DEFAULT)         -
CD              M = 5... 5TH ORDER  FLUX  APPROXIMATION.                 -
CD              M = 6... 6TH ORDER  FLUX  APPROXIMATION.                 -
CD              N = 0... FLAT LEAKAGE APPROXIMATION.                     -
CD              N = 1... LINEAR LEAKAGE APPROXIMATION (DEFAULT).         -
CD              N = 2... QUADRATIC LEAKAGE APPROXIMATION.                -
CD                                                                       -
CD                                                                       -
CD              LEADING ZEROS ARE IRRELEVANT.                            -
CD              THEREFORE, DEFAULT VALUES FOR LMN ARE 241                -
CD              M = 5 OR 6 ONLY FOR HEXAGONAL GEOMETRY.                  -
CD              IN 3D HEXAGONAL GEOMETRY M = 5 OR 6 PROVIDES             -
CD              FULL EXPANSION IN THE X AND Y PLANE, Z DIRECTION         -
CD              IS EXPANDED TO 4TH ORDER.                                -
CD                                                                       -
CD                                                                       -
CD  3  13-18    ANGULAR APPROXIMATION.                                  -
CD              ENTER 2 DIGIT NUMBER MN WHERE                            -
CD                                                                       -
CD              M IS THE ORDER OF THE PN EXPANSION OF THE FLUX.          -
CD              N IS THE ORDER OF THE PN EXPANSION OF THE LEAKAGE.       -
CD                                                                       -
CD              HEXAGONAL AND CARTESIAN GEOMETRIES:                      -
CD              M = 1... P1 FLUX EXPANSION.                              -
CD              M = 3... P3 FLUX EXPANSION (DEFAULT).                    -
CD              M = 5... P5 FLUX EXPANSION                               -
CD              N = 1... P1 LEAKAGE EXPANSION.                           -
CD              N = 3... P3 LEAKAGE EXPANSION (DEFAULT)                  -
CD              N = 5... P5 LEAKAGE EXPANSION                            -
CD                                                                       -
```

68

```
CD                    LEADING ZEROS ARE IRRELEVANT.                     -
CD                    THEREFORE, DEFAULT VALUE FOR MN IS 33.            -
CD                    MN EQUAL TO 11 CORRESPONDS TO DIFFUSION CALCULATION. -
CD                    IF MN IS NEGATIVE, SIMPLIFIED SPHERICAL HARMONICS  -
CD                    ARE USED.                                         -
CD                                                                      -
CD  4   19-24   COARSE-MESH REBALANCE ACCELERATION CONTROL.             -
CD                 -1...NO COARSE-MESH REBALANCE ACCELERATION.          -
CD             .GT.0...NUMBER OF FINE MESH PER REBALANCE MESH IN X- AND  -
CD                    Y-DIRECTIONS - CARTESIAN GEOMETRY ONLY (DEFAULT=6).-
CD                                                                      -
CD  5   25-30   NUMBER OF XY-PLANE PARTIAL CURRENT SWEEPS PER GROUP      -
CD             PER AXIAL MESH SWEEP PER OUTER ITERATION.                 -
CD             (DEFAULT = 0 - LET CODE DECIDE).                          -
CD                                                                      -
CD  6   31-36   NUMBER OF AXIAL PARTIAL CURRENT SWEEPS PER GROUP         -
CD             PER AXIAL PARTIAL CURRENT SWEEP                           -
CD             PER OUTER ITERATION (DEFAULT=0 - LET CODE DECIDE)         -
CD                                                                      -
CD  7   37-42   HALF-DOMAIN SYMMETRY FLAG.                               -
CD                 -1...DO NOT USE 30 DEGREE (HEXAGONAL GEOMETRY) OR 45  -
CD                    DEGREE (CARTESIAN GEOMETRY) PLANAR SYMMETRY EVEN   -
CD                    IF SUCH SYMMETRY EXISTS.                           -
CD                  0...USE 30 DEGREE (HEXAGONAL GEOMETRY) OR 45 DEGREE  -
CD                    (CARTESIAN GEOMETRY) PLANAR SYMMETRY IF SUCH       -
CD                    SYMMETRY EXISTS (DEFAULT).                         -
C                                                                       -
CN                    THE NODAL OPTION IS INVOKED IN HEXAGONAL GEOMETRY BY -
CN                    SPECIFYING GEOMETRY-TYPE SENTINELS BETWEEN 110 AND 128 -
CN                    ON THE A.NIP3 TYPE 03 CARD.                       -
CN                                                                      -
CD  8   43-48   ASYMPTOTIC SOURCE EXTRAPOLATION SENTINEL.                -
CD                 -1...PERFORM ASYMPTOTIC SOURCE EXTRAPOLATION ON THE   -
CD                    NODAL OUTER ITERATIONS ONLY ON FISSION SOURCES.    -
CD                    NO EXTRA-SPACE IS NEEDED TO STORE PREVIOUS OUTER   -
CD                    ITERATION CURRENTS.                                -
CD                  0...PERFORM ASYMPTOTIC SOURCE EXTRAPOLATION ON THE   -
CD                    NODAL OUTER ITERATIONS ON FISSION SOURCES AND      -
CD                    CURRENTS.                                          -
CD                  1...DO NOT PERFORM ASYMPTOTIC SOURCE EXTRAPOLATION   -
CD                                                                      -
CD  9   49-54   ANISOTROPIC SCATTERING APPROXIMATION NPNO.               -
CD                  0...ISOTROPIC SCATTERING (DEFAULT).                  -
CD                  N...ANISOTROPIC SCATTERING ORDER (.LE.3).            -
CD                    N MUST BE LESS THAN OR EQUAL TO MAXORD, MAXIMUM    -
CD                    ANISOTROPIC ORDER SPECIFIED IN ISOTXS OR COMPXS    -
CD                    FILES.                                             -
CD                                                                      -
CD 10   55-60   EXTENDED TRANSPORT APPROXIMATION (NXTR) ON TOTAL         -
CD             CROSS SECTION.                                            -
CD                 -1...IF NPNO .EQ. 0 USE TOTAL CROSS SECTION PROVIDED  -
CD                    IN COMPXS FILE, OTHERWISE USE TRANSPORT CROSS      -
CD                    SECTION INSTEAD OF TOTAL ONE.                      -
CD                  0...(DEFAULT).                                       -
CD                    IF NPNO .EQ. 0 USE TRANSPORT CROSS SECTION         -
CD                    PROVIDED IN COMPXS FILE.                           -
CD                    IF NPNO .GT. 0 AND NPNO .EQ. MAXORD USE TOTAL      -
CD                    CROSS SECTION PROVIDED IN COMPXS FILE.             -
CD                    IF NPNO .GT. 0 AND NPNO .LT. MAXORD CORRECT TOTAL  -
CD                    CROSS SECTION PROVIDED IN COMPXS FILE WITH         -
CD                    EXTENDED TRANSPORT APPROXIMATION TAKING INTO       -
CD                    ACCOUNT THE NPNO + 1 ORDER SCATTERING CROSS        -
CD                    SECTIONS (BHS APPROXIMATION).                      -
CD                  N...IF NXTR .LE. NPNO USE TOTAL CROSS SECTION.       -
CD                    IF NXTR .GT. NPNO PERFORM EXTENDED TRANSPORT       -
CD                    APPROXIMATION ON TOTAL CROSS SECTION FROM NPNO + 1 -
CD                    TO NXTR ORDER.                                     -
CD                                                                      -
CD 11   61-66   OMEGA TRANSFORMATION ACCELERATION OPTION.                -
CD                  0...OMEGA TRANSFORMATION ACCELERATION IS APPLIED. IN -
CD                    THIS CASE THE NUMBER OF INNER ITERATIONS PER GROUP -
CD                    CALCULATED BY THE CODE IS SIGNIFICANTLY LESS THAN  -
```

69

```
CD                    THE STANDARD CASE.                        -
CD                    1...OMEGA TRANSFORMATION ACCELERATION IS NOT APPLIED.  -
CD                                                              -
CD 12   67-72   RADIAL INNER ITERATION ALGORITHM.              -
CD                    0...PARTITIONED MATRIX ALGORITHM (DEFAULT).  -
CD                    1...FULL MATRIX ALGORITHM. THIS ALGORITHM IS SOMETIMES  -
CD                       NECESSARY WITH VERY SMALL NODE MESH SIZE WHERE  -
CD                       DIVERGENCE CAN OCCUR. THIS ALGORYTHM REQUIRES A  -
CD                       SIGNIFICANTLY LARGER COMPUTATIONAL TIME.  -
CD                       FULL MATRIX ALGORYTHM IS IMPOSED WHEN ONLY ONE  -
CD                       OUTER ITERATION IS SPECIFIED (FIXED SOURCE  -
CD                       PROBLEM WITHOUT FISSION EVENTS).       -
CD                    N...IF A POSITIVE NUMBER N GREATER THAN 1 AND SMALLER  -
CD                       THAN THE TOTAL NUMBER OF INNER ITERATIONS IS  -
CD                       SPECIFIED, THE FULL MATRIX ALGORITHM IS APPLIED  -
CD                       WITH FREQUENCY N DURING THE INNER ITERATIONS.  -
CD                       IF N GREATER OR EQUAL TO THE TOTAL NUMBER OF INNER  -
CD                       ITERATION FOR THE GROUP THE PARTITIONED MATRIX  -
CD                       ALGORITHM IS APPLIED.                  -
CD                                                              -
CR          PARAMETERS FOR VARIATIONAL NODAL OPTION (TYPE 12)  -
CR                    (CONTINUATION)                            -
C                                                              -
CL     FORMAT-----(I2,4X,3I6)                                  -
C                                                              -
CD  #   COLUMNS          CONTENTS...IMPLICATIONS, IF ANY       -
CD  =   =======   =======================================================-
CD 13   1-2     12                                             -
CD                                                              -
CD 14   7-12    NHFLUX CONTENT                                 -
CD                    0...BOTH FLUXES AND PARTIAL CURRENTS ARE STORED ON  -
CD                       NHFLUX FILE                           -
CD                    1...ONLY FLUXES ARE STORED ON NHFLUX FILE  -
CD                    2...ONLY PARTIAL CURRENTS ARE STORED ON NHFLUX FILE  -
CD                                                              -
CD 15   13-18   PERTURBATION OPTION                           -
CD                    0...NO EFFECT                            -
CD                    1...ANGULAR AND SPATIAL APPROXIMATION FOR SOURCE  -
CD                       EXPANSION ARE SET EQUAL TO THE ONES USED FOR THE  -
CD                       FLUX. THIS IS NEEDED FOR STORING ON NHFLUX A  -
CD                       COMPLETE EXPANSION OF THE FLUX MOMENTS. AS A  -
CD                       CONSEQUENCE SLIGHTLY DIFFERENCES WILL BE OBSERVED  -
CD                       IN THE RESULTS COMPARED AGAINST A LESS ACCURATE  -
CD                       EXPANSION OF THE SOURCE.              -
CD                                                              -
CD                                                              -
CD 16   19-24   HARMONIC CALCULATION                          -
CD                    N...THE NTH HARMONIC WILL BE CALCULATED (0 IS THE  -
CD                       FUNDAMENTAL MODE). NOT YET OPERATIONAL.  -
CD                                                              -
CN              IN FREE FORMAT THE NODAL VARIATIONAL PARAMETERS ARE  -
CN              PROVIDED ONLY IN ONE CARD OF TYPE 12. ADDITIONAL TYPE  -
CN              12 CARDS WILL BE IGNORED.                      -
CN              IN FIXED FORMAT, IF THE CONTINUATION CARD OF TYPE 12  -
CN              IS NOT PRESENT, VALUES OF PARAMETERS 14, 15, AND 16  -
CN              ARE SET TO ZERO.                               -
CD                                                              -
CN              THE NODAL OPTION IS INVOKED IN CARTESIAN GEOMETRY BY  -
CN              SPECIFYING GEOMETRY-TYPE SENTINELS 40 OR 44 ON THE  -
CN              A.NIP3 TYPE 03 CARD AND PROVIDING ANY ACCEPTABLE  -
CN              (E.G. DEFAULT) VALUES ON A.DIF3D TYPE 12 CARD.  -
CN                                                              -
CN         *** THE CARTESIAN-GEOMETRY NODAL OPTION MAY NOT BE  -
CN              AVAILABLE IN ALL VERSIONS OF DIF3D. ***        -
C                                                              -
CN              IT IS IMPORTANT THAT THE NUMBER OF FINE MESH PER  -
CN              REBALANCE MESH BE CHOSEN SUCH THAT THE AVERAGE  -
CN              REBALANCE MESH SPACING IS APPROXIMATELY 30 TO 40 CM IN  -
CN              THE XY-PLANE.  THUS, FOR EXAMPLE, IF THE AVERAGE FINE  -
CN              MESH SPACING IS DELTA CM, THEN THE INTEGER INPUT IN  -
CN              COLS. 19-24 SHOULD BE BETWEEN 30/DELTA AND 40/DELTA.  -
C                                                              -
```

```
CN             IF SLOW (OR DIVERGENT) ITERATIVE CONVERGENCE BEHAVIOR  -
CN             IS OBSERVED, THE NUMBER OF PARTIAL CURRENT SWEEPS      -
CN             SPECIFIED IN COLS. 25-30 AND 31-36 SHOULD BE INCREASED.-
C                                                                     -
C---------------------------------------------------------------------
CEOF
```

```
C*********************************************************************-
C                                                                    -
C                         PREPARED 9/26/79 AT ANL                    -
C                         LAST REVISED 12/20/01                      -
C                                                                    -
CF            A.HMG4C                                                -
CE           INPUT FOR CCCC TO ARC SYSTEM CROSS SECTION HOMOGENIZATION -
C                                                                    -
CN                       THIS IS A USER-SUPPLIED BCD DATA SET.       -
CN                       THE LIST FOR EACH RECORD IS GIVEN IN TERMS  -
CN                       OF THE BCD FORMAT OF THAT DATA CARD.        -
CN                       COLUMNS 1-2 NORMALLY CONTAIN THE CARD TYPE  -
CN                       NUMBER.                                     -
CN                       A BLANK FIELD GIVES THE DEFAULT OPTION      -
CN                       INDICATED.                                  -
CN                       ALL INPUT CARDS ARE OPTIONAL.               -
C                                                                    -
C*********************************************************************

C--------------------------------------------------------------------
CR             PROBLEM TITLE (TYPE 01)                               -
C                                                                    -
CL      FORMAT-----(I2,4X,11A6)                                      -
C                                                                    -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY             -
CD  =  =======  =======================================================-
CD  1  1-2      01                                                   -
CD                                                                   -
CD  2  7-72     ANY ALPHANUMERIC CHARACTERS.                         -
C                                                                    -
CN               UP TO SIX TYPE 01 CARDS MAY BE USED.                -
C                                                                    -
C--------------------------------------------------------------------


C--------------------------------------------------------------------
CR             PROBLEM OPTIONS (TYPE 02)                             -
C                                                                    -
CL      FORMAT-----(I2,4X,8I6)                                       -
C                                                                    -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY             -
CD  =  =======  =======================================================-
CD  1  1-2      02                                                   -
CD                                                                   -
CD  2  7-12     SIZE OF MAIN CORE CONTAINER ARRAY IN REAL*8 WORDS    -
CD             (SINGLE WORDS ON CDC SYSTEMS). (DEFAULT=20000).       -
CD                                                                   -
CD  3  13-18    PRINT FILE MASTER CONTROL FLAG.                      -
CD             0...PRINT GENERAL RUN INFORMATION AND REQUESTED EDITS -
CD                (DEFAULT).                                         -
CD             1...SUPPRESS ALL PRINTING EXCEPT DIAGNOSTICS.         -
CD                                                                   -
CD  4  19-24    COMPXS EDIT FLAG.                                    -
CD             0...NO EDIT (DEFAULT).                                -
CD             1...PRINT COMPLETE EDIT OF THE CREATED COMPXS FILE.   -
CD             2...WRITE COMPLETE EDIT OF THE CREATED COMPXS FILE    -
CD                ON THE AUXILIARY OUTPUT FILE.                      -
CD             3...COMPXS EDIT WRITTEN ON BOTH PRINT AND AUXILIARY   -
CD                OUTPUT FILE FT10.                                  -
CD                                                                   -
CD  5  25-30    ISOTXS EDIT FLAG.                                    -
CD             0...NO EDIT (DEFAULT).                                -
CD             1...PRINT RUNNING EDIT OF ISOTXS (I.E. NOT EVERY      -
CD                ISOTOPE ON THE FILE IS PRINTED, ONLY THOSE         -
CD                ACTUALLY REFERENCED).                              -
CD             2...WRITE RUNNING EDIT OF ISOTXS ON THE AUXILIARY     -
CD                OUTPUT FILE.                                       -
CD             3...RUNNING EDIT OF ISOTXS WRITTEN ON BOTH PRINT      -
CD                AND AUXILIARY OUTPUT FILES.                        -
CD                                                                   -
CD  6  31-36    POINTR DEBUGGING EDIT FLAG.                          -
```

```
CD                  0...NO DEBUGGING PRINTOUT (DEFAULT).            -
CD                  1...DUMP PRINTOUTS ONLY.                        -
CD                  2...TRACE PRINTOUTS ONLY.                       -
CD                  3...BOTH TRACE AND DUMP PRINTOUT.               -
CD                                                                  -
CD                  NOTE THAT HMG4C CONTAINS NO DUMPS, I.E. 1 IS NOT -
CD                  A RELEVANT VALUE FOR THIS FLAG.                 -
CD                                                                  -
CD  7  37-42  PROMPT FISSION SPECTRUM OPTION FLAG.                  -
CD                  0...IGNORE ISOTOPE FISSION VECTORS, IF PRESENT IN -
CD                      ISOTXS, AND USE THE SET FISSION VECTOR FOR ALL -
CD                      COMPOSITIONS (DEFAULT). IF A SET FISSION SPECTRUM -
CD                      IS NOT PRESENT IN ISOTXS, THE COMPOSITION FISSION -
CD                      SPECTRA WILL BE COMPUTED BY THE TOTAL FISSION -
CD                      SOURCE WEIGHTING METHOD USING ISOTOPE FISSION -
CD                      VECTORS.                                    -
CD                  1...USE ISOTOPE FISSION VECTORS, IF PRESENT IN ISOTXS, -
CD                      TO COMPUTE COMPOSITION FISSION VECTORS WITH TOTAL -
CD                      FISSION SOURCE WEIGHTING, I.E., UNDER ASSUMPTION -
CD                      THAT FLUX IS GROUP INDEPENDENT. THIS IS THE -
CD                      PREFERRED WEIGHTING METHOD. IF AN ISOTOPE FISSION -
CD                      VECTOR IS NOT PRESENT, THE SET FISSION VECTOR WILL -
CD                      BE USED IN ITS PLACE.                       -
CD                  2...USE ISOTOPE FISSION VECTORS, IF PRESENT IN ISOTXS, -
CD                      TO COMPUTE COMPOSITION FISSION VECTORS WITH -
CD                      NU*SIGMA(FISSION) WEIGHTING. THIS METHOD OF -
CD                      COMPUTING A FISSION SPECTRUM IS NOT RECOMMENDED. -
CD                      IF AN ISOTOPE FISSION VECTOR IS NOT PRESENT, THE -
CD                      SET FISSION VECTOR WILL BE USED IN ITS PLACE. -
CD                                                                  -
CD  8  43-48  AUXILIARY OUTPUT FILE MASTER CONTROL FLAG.            -
CD                  0...WRITE GENERAL RUN INFORMATION AND REQUESTED -
CD                      EDITS ON AUXILIARY OUTPUT FILE (DEFAULT).   -
CD                  1...SUPPRESS ALL OUTPUT TO AUXILIARY FILE.      -
CD                                                                  -
CD                  NOTE THAT ERROR DIAGNOSTICS ARE NOT WRITTEN ON THE -
CD                  AUXILIARY OUTPUT FILE.                          -
CD                                                                  -
CD  9  49-54  EDIT FLAG FOR A SUPPLIED COMPXS FILE.                 -
CD                  0...NO EDIT (DEFAULT).                          -
CD                  1...PRINT COMPLETE EDIT OF SUPPLIED COMPXS FILE. -
CD                  2...WRITE COMPLETE EDIT OF SUPPLIED COMPXS FILE ON -
CD                      THE AUXILIARY OUTPUT FILE.                  -
CD                  3...EDIT OF SUPPLIED COMPXS WRITTEN ON BOTH PRINT AND -
CD                      AUXILIARY OUTPUT FILES.                     -
C                                                                   -
C-------------------------------------------------------------------


C-------------------------------------------------------------------
C                                                                   -
CR          SCATTERING CROSS SECTION TRUNCATION OPTION  (TYPE 03)   -
C                                                                   -
CL      FORMAT-----(I2,4X,E12.5)                                    -
C                                                                   -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY             -
CD  =  =======  ========================================================-
CD  1  1-22   03                                                    -
CD                                                                  -
CD  2  7-18   SCATTERING MATRIX TRUNCATION FRACTION (DEFAULT=1.0)   -
C                                                                   -
CN                  THE SCATTERING CROSS SECTION BANDWIDTH OF A     -
CN                  COMPOSITION IN FILE COMPXS IS TRUNCATED AT      -
CN                  THE POINT WHERE THE INPUT FRACTION (COL 7 -18)  -
CN                  OF THE TOTAL SCATTERING CROSS SECTION HAS       -
CN                  BEEN ACCUMULATED.  A VALUE OF .999 IS           -
CN                  GENERALLY SUFFICIENT TO RETAIN THE RIGOR        -
CN                  OF A CALCULATION WHILE SIGNIFICANTLY REDUCING   -
CN                  THE SCATTERING BANDWIDTH AND HENCE, THE I/O     -
CN                  TIMES ASSOCIATED WITH THE SCATTERING SOURCE     -
CN                  DETERMINATION IN A NEUTRONICS CALCULATION.      -
C                                                                   -
```

```
C------------------------------------------------------------------------


C------------------------------------------------------------------------
CR          OPTIONAL INPUT DATA FOR CSE010 (CONVERTS XS.ISO FORMAT    -
CR          CROSS SECTIONS TO ISOTXS FORMAT) (TYPE 04)                -
C                                                                     -
CL     FORMAT-----(I2,4X,4I6)                                         -
C                                                                     -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY              -
CD  =  ======   =========================================================-
CD  1  1-2      04                                                    -
CD                                                                    -
CD  2  7-12     GENERATE TOTAL OR USE TRANSPORT CROSS SECTION IN      -
CD              ISOTXS DATA SET FOR THE P0 AND P1 TOTAL CROSS SECTION -
CD              GENERATED FROM XS.ISO DATA SET                        -
CD              0...GENERATE TOTAL CROSS SECTION (DEFAULT)            -
CD                                                                    -
CD                  P0 TOTAL CROSS SECTION=P1 TOTAL CROSS SECTION=P1  -
CD                  TRANSPORT CROSS SECTION+ANISO-ELASTIC P0 IN       -
CD                  GROUP SCATTERING CROSS SECTION                    -
CD                                                                    -
CD                  1...SUBSTITUTE THE TRANSPORT CROSS SECTION FROM   -
CD                  XS.ISO IN PLACE OF THE TOTAL CROSS SECTION. ALSO  -
CD                  BALANCE CROSS SECTIONS AS PRESCRIBED IN THE       -
CD                  DEFAULT FOR COLS. 13-18 BELOW.                    -
CD                                                                    -
CD                  P0 TOTAL CROSS SECTION=P1 TOTAL CROSS SECTION=P1  -
CD                  TRANSPORT CROSS SECTION                           -
CD                                                                    -
CD  2  13-18    BALANCE THE CROSS SECTIONS                            -
CD              0...BALANCE THE  CROSS SECTIONS SO THAT THE TOTAL     -
CD                  EQUALS THE SUM OF THE PARTIALS. THIS IS DONE      -
CD                  EXPLICITLY BY ADJUSTING THE ELASTIC IN-GROUP      -
CD                  SCATTERING CROSS SECTION (DEFAULT)                -
CD                                                                    -
CD                  ELASTIC IN-GROUP SCATTERING=TOTAL CROSS SECTION-  -
CD                  INELASTIC SCATTERING-(N,2N) SCATTERING-FISSION-   -
CD                  (N,GAMMA)-(N,P)-(N,ALPHA)                         -
CD                                                                    -
CD                  1...DO NOT BALANCE THE CROSS SECTIONS             -
CD                                                                    -
CD                  THE CROSS SECTIONS ARE NOT BALANCED IF THE ENTIRE -
CD                  CARD TYPE IS ABSENT                               -
CD                                                                    -
CD  3  19-24    N,2N MATRIX CROSS SECTION - REACTION OR PRODUCTION    -
CD              BASED                                                 -
CD                                                                    -
CD                  N,2N(G)=FACT*SUM(N,2N(G-G'))                      -
CD                                  G'                                -
CD                                                                    -
CD                  0...REACTION BASED FACT=1.0 (DEFAULT)             -
CD                  1...PRODUCTION BASED FACT=0.5                     -
CD                                                                    -
CD  4  25.30    ADD OR DELETE FACTOR OF 2L+1 TO HIGH-ORDER SCATTERING -
CD              (ELASTIC, INELASTIC, N2N) CROSS SECTIONS IN ISOTXS    -
CD              FORMAT                                                -
CD              0...NO ACTION TAKEN (DEFAULT)                         -
CD              1...MULTIPLY EACH SCATTERING TERM BY 1/(2L+1)         -
CD              2...MULTIPLY EACH SCATTERING TERM BY (2L+1)           -
CD                                                                    -
CD              IF CROSS SECTIONS COME FROM MC**2-2, THEY DO NOT      -
CD              CONTAIN THE FACTOR (2L+1).                            -
CD                                                                    -
CD              IF CROSS SECTIONS COME FROM EPRI-CELL, THE SCATTERING -
CD              CROSS SECTIONS HAVE BEEN MULTIPLIED BY THE FACTOR     -
CD              (2L+1) WHERE L IS THE EXPANSION INDEX.                -
CD                                                                    -
CD              NOTE THAT DOT4 REQUIRES THAT THE CROSS SECTION FILES  -
CD              HAVE LEGENDRE EXPANSION DATA WHICH HAVE BEEN          -
CD              MULTIPLIED BY 2L+1, WHERE L IS THE EXPANSION INDEX.   -
CD              ON THE OTHER HAND, TWODANT EXPECTS SCATTERING CROSS   -
```

74

```
CD              SECTIONS WHICH DO NOT INCLUDE (2L+1). DOT4, TWODANT  -
CD              AND ANISN ARE THE ONLY PRODUCTION CODES CURRENTLY    -
CD              AT ANL WHICH USE THE HIGHER ORDER SCATTERING CROSS   -
CD              SECTION TERMS.                                       -
CD                                                                   -
CD                                                                   -
CD              APPROPRIATE FLAGS TO USE IN COL. 25-30               -
CD                                                                   -
CD                                                                   -
CD                          CROSS SECTION GENERATOR                  -
CD               *                                                   -
CD                *                                                  -
CD                 *                                                 -
CD                  *    MC**2-2 OR NJOY        EPRI-CELL            -
CD                 *                                                 -
CD                  *********************************                -
CD         TWODANT*                                                  -
CD            OR  *                                                  -
CD          ANISN *         0                   1                    -
CD                *                                                  -
CD          DOT4  *         2                   0                    -
CD                                                                   -
CD                                                                   -
C                                                                    -
CN              MODULE CSE010 IS USED LOCALLY AT ANL ONLY AND THIS   -
CN              MODULE CONVERTS A LOCAL FORMAT (XS.ISO) TO CCCC      -
CN              FORMAT ISOTXS                                        -
C                                                                    -
C-------------------------------------------------------------------
```

75

```
C*********************************************************************
C                                                                    -
C                         Latest version 12/20/01                    -
C                                                                    -
CF          A.MASFLO                                                 -
CE          INPUT FOR REBUS-PC SUMMARY MASS FLOW EDITS               -
C                                                                    -
CN                       THIS BCD DATASET MAY BE WRITTEN EITHER      -
CN                       IN FREE FORMAT (UNFORM=A.MASFLO) OR         -
CN                       ACCORDING TO THE FORMATS SPECIFIED FOR EACH -
CN                       CARD TYPE (DATASET=A.MASFLO).               -
CN                                                                   -
CN                       COLUMNS 1-2 MUST CONTAIN THE CARD TYPE NUMBER. -
CN                                                                   -
CN                       A BLANK FIELD GIVES THE DEFAULT OPTION      -
CN                       INDICATED.                                  -
C                                                                    -
C*********************************************************************


C--------------------------------------------------------------------
CR            PROBLEM TITLE (TYPE 01)                                -
C                                                                    -
CL     FORMAT-----(I2,4X,11A6)                                       -
C                                                                    -
CD      COLUMNS           CONTENTS...IMPLICATIONS, IF ANY            -
CD      =======  =========================================================-
CD      1-2      01                                                  -
CD                                                                   -
CD      7-72     ANY ALPHANUMERIC CHARACTERS.                        -
C                                                                    -
C--------------------------------------------------------------------


C--------------------------------------------------------------------
CR            ISOTOPE SPECIFICATIONS (TYPE 02)                       -
C                                                                    -
CL     FORMAT-----(I2,4X,5(I6,A6))                                   -
C                                                                    -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY             -
CD  =  =======  =========================================================-
CD  1  1-2      02                                                   -
CD                                                                   -
CD  2  7-12     ACTIVE ISOTOPE NUMBER.                               -
CD                                                                   -
CD  3  13-18    ACTIVE ISOTOPE ABSOLUTE LABEL.                       -
CD                                                                   -
CD  4  19-24    ACTIVE ISOTOPE NUMBER.                               -
CD                                                                   -
CD  5  25-30    ACTIVE ISOTOPE ABSOLUTE LABEL.                       -
CD                                                                   -
CD  6  31-36    ACTIVE ISOTOPE NUMBER.                               -
CD                                                                   -
CD  7  37-42    ACTIVE ISOTOPE ABSOLUTE LABEL.                       -
CD                                                                   -
CD  8  43-48    ACTIVE ISOTOPE NUMBER.                               -
CD                                                                   -
CD  9  49-54    ACTIVE ISOTOPE ABSOLUTE LABEL.                       -
CD                                                                   -
CD 10  55-60    ACTIVE ISOTOPE NUMBER.                               -
CD                                                                   -
CD 11  60-66    ACTIVE ISOTOPE ABSOLUTE LABEL.                       -
C                                                                    -
CN                       THE DEFAULT LABELS CORRESPONDING TO THE 22 STANDARD -
CN                       ISOTOPES ARE AS LISTED BELOW.               -
CN                            1...TH232                              -
CN                            2...PA233                              -
CN                            3...U-233                              -
CN                            4...U-234                              -
CN                            5...U-235                              -
CN                            6...U-236                              -
CN                            7...U-238                              -
```

```
CN                        8...NP237                                    -
CN                        9...PU236                                    -
CN                       10...PU238                                    -
CN                       11...PU239                                    -
CN                       12...PU240                                    -
CN                       13...PU241                                    -
CN                       14...PU242                                    -
CN                       15...AM241                                    -
CN                       16...AM242                                    -
CN                       17...AM243                                    -
CN                       18...CM242                                    -
CN                       19...CM243                                    -
CN                       20...CM244                                    -
CN                       21...CM245                                    -
CN                       22...CM246                                    -
CN                                                                     -
CN            AT THIS TIME, THE MASS FLOW SUMMARY WILL EDIT DATA FOR   -
CN            ONLY ISOTOPES 1-7, AND 10-14.  LABELS GIVEN ON THIS      -
CN            CARD MUST CORRESPOND TO LABELS SUPPLIED ON THE CARD      -
CN            TYPES 09-11 BELOW.                                       -
C                                                                      -
C----------------------------------------------------------------------


C----------------------------------------------------------------------
CR            PLANT SPECIFICATIONS (TYPE 03)                           -
C                                                                      -
CL    FORMAT-----(I2,4X,4E12.6,2I6)                                    -
C                                                                      -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY               -
CD  =  =======  =========================================================-
CD  1  1-2      03                                                     -
CD                                                                     -
CD  2  7-18     EMW, MW ELECTRICAL (DEFAULT=1000.0)                    -
CD                                                                     -
CD  3  19-30    THMW, MW THERMAL (DEFAULT=2740.0)                      -
CD                                                                     -
CD  4  31-42    CF, PLANT CAPACITY FACTOR IN PER CENT (DEFAULT=75.0)   -
CD                                                                     -
CD  5  43-54    FPD, CYCLE LENGTH, FULL POWER DAYS (DEFAULT=273.75)    -
CD                                                                     -
CD  6  55-60    NPOW, RATIO OF ACTUAL POWER TO POWER USED FOR MASS     -
CD              FLOW CALCULATION (DEFAULT=2)                           -
CD                                                                     -
CD  7  61-66    NZONE, NUMBER OF REACTOR ZONES USED FOR MASS FLOW      -
CD              EDITS,  THE STANDARD ZONES ARE CORE, AXIAL BLANKET,    -
CD              RADIAL BLANKET, AND INTERNAL BLANKET.  NZONE SHOULD    -
CD              BE SET TO 3 UNLESS THERE ARE INTERNAL BLANKETS, IN     -
CD              WHICH CASE NZONE SHOULD BE SET TO 4. (DEFAULT=3)       -
C                                                                      -
C----------------------------------------------------------------------


C----------------------------------------------------------------------
C                                                                      -
CR            FUEL RESIDENCE DETAILS (TYPE 04)                         -
C                                                                      -
CL    FORMAT-----(I2,4X,7I6)                                           -
C                                                                      -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY               -
CD  =  =======  =========================================================-
CD  1  1-2      04                                                     -
CD                                                                     -
CD  2  7-12     NC, CORE RESIDENCE, NUMBER OF CYCLES (DEFAULT=2)       -
CD                                                                     -
CD  3  13-18    NRB, RADIAL BLANKET RESIDENCE, NUMBER OF CYCLES        -
CD                   (DEFAULT=5)                                       -
CD                                                                     -
CD  4  19-24    NIB, INNER BLANKET RESIDENCE, NUMBER OF CYCLES         -
CD                   (DEFAULT=0)                                       -
CD                                                                     -
CD  5  25-30    NFERAB, AXIAL BLANKET FERTILE TYPE, 0...URANIUM,       -
```

```
CD               1...THORIUM (DEFAULT=0)                        -
CD                                                             -
CD  6  31-36   NFERRB, RADIAL BLANKET FERTILE TYPE, 0...URANIUM, -
CD               1...THORIUM (DEFAULT=0)                        -
CD                                                             -
CD  7  37-42   NFERIB, INNER BLANKET FERTILE TYPE, 0...URANIUM, -
CD               1...THORIUM (DEFAULT=0)                        -
CD                                                             -
CD  8  43-48   NORB, OUTER RADIAL BLANKET RESIDENCE, NUMBER OF CYCLES -
CD               (DEFAULT=5)                                    -
C                                                             -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
C                                                             -
CR          EXTERNAL SPECIFICATIONS (TYPE 05)                 -
C                                                             -
CL     FORMAT-----(I2,4X,3E12.6,I6,2E12.5)                    -
C                                                             -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY        -
CD  =  =======  =========================================================-
CD  1  1-2      05                                            -
CD                                                             -
CD  2  7-18     EXT, EXTERNAL CYCLE TIME IN CALENDAR YEARS     -
CD               (DEFAULT=1.0)                                 -
CD                                                             -
CD  3  19-30    FLOSS, FRACTIONAL LOSS IN REPROCESSING (DEFAULT=0.02)  -
CD                                                             -
CD  4  31-42    EU235, U-235 FRACTION IN FERTILE URANIUM       -
CD               (DEFAULT=0.002)                               -
CD                                                             -
CD  5  43-48    NFIS, 0...U-235 NOT INCLUDED IN FISSILE DEFINITION, -
CD               1...U-235 INCLUDED IN FISSILE DEFINITION      -
CD               (DEFAULT=1)                                   -
CD                                                             -
CD  6  59-60    BEGINK, BEGINNING OF CYCLE KEFF                -
CD                                                             -
CD  7  61-72    FINALK, END OF CYCLE KEFF                      -
C                                                             -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
C                                                             -
CR          BREEDING RATIO SPECIFICATIONS (TYPE 06)           -
C                                                             -
CL     FORMAT-----(I2,4X,5E12.6)                              -
C                                                             -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY        -
CD  =  =======  =========================================================-
CD  1  1-2      06                                            -
CD                                                             -
CD  2  7-18     CORE BREEDING RATIO                            -
CD                                                             -
CD  3  19-30    AXIAL BLANKET BREEDING RATIO                   -
CD                                                             -
CD  4  31-42    RADIAL BLANKET BREEDING RATIO                  -
CD                                                             -
CD  5  43-54    INTERNAL BLANKET BREEDING RATIO                -
CD                                                             -
CD  6  55-66    OUTER RADIAL BLANKET BREEDING RATIO            -
C                                                             -
CN             IF CARD TYPES 09 AND/OR TYPE 10 CONTAIN DATA FOR PA233,-
CN             THE INPUT BREEDING RATIOS WILL BE MODIFIED BY   -
CN             ASSUMING THAT ALL OF THE PA233 MASS CORRESPONDS TO -
CN             U-233                                           -
C                                                             -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
```

```
C                                                                        -
CR              POWER SPLIT SPECIFICATIONS (TYPE 07)                     -
C                                                                        -
CL     FORMAT-----(I2,4X,5E12.6)                                         -
C                                                                        -
CD  #   COLUMNS            CONTENTS...IMPLICATIONS, IF ANY               -
CD  =   =======   ======================================================-
CD  1   1-2       07                                                     -
CD                                                                       -
CD  2   7-18      PER CENT OF POWER IN THE CORE                          -
CD                                                                       -
CD  3   19-30     PER CENT OF POWER IN THE AXIAL BLANKET                 -
CD                                                                       -
CD  4   31-42     PER CENT OF POWER IN THE RADIAL BLANKET                -
CD                                                                       -
CD  5   43-54     PER CENT OF POWER IN THE INTERNAL BLANKET              -
CD                                                                       -
CD  6   55-66     PER CENT OF POWER IN THE OUTER RADIAL BLANKET          -
C                                                                        -
C------------------------------------------------------------------------

C------------------------------------------------------------------------
C                                                                        -
CR              HEAVY METAL SPECIFICATIONS (TYPE 08)                     -
C                                                                        -
CL     FORMAT-----(I2,4X,5E12.6)                                         -
C                                                                        -
CD  #   COLUMNS            CONTENTS...IMPLICATIONS, IF ANY               -
CD  =   =======   ======================================================-
CD  1   1-2       08                                                     -
CD                                                                       -
CD  2   7-18      KG OF HEAVY METAL IN THE CORE                          -
CD                                                                       -
CD  3   19-30     KG OF HEAVY METAL IN THE AXIAL BLANKET                 -
CD                                                                       -
CD  4   31-42     KG OF HEAVY METAL IN THE RADIAL BLANKET                -
CD                                                                       -
CD  5   43-54     KG OF HEAVY METAL IN THE INTERNAL BLANKET              -
CD                                                                       -
CD  6   55-66     KG OF HEAVY METAL IN THE OUTER RADIAL BLANKET          -
C                                                                        -
C------------------------------------------------------------------------

C------------------------------------------------------------------------
C                                                                        -
CR           BEGINNING OF EQUILIBRIUM CYCLE MASSES (TYPE 09)             -
C                                                                        -
CL     FORMAT-----(I2,4X,A6,5E12.6)                                      -
C                                                                        -
CD  #   COLUMNS            CONTENTS...IMPLICATIONS, IF ANY               -
CD  =   =======   ======================================================-
CD  1   1-2       09                                                     -
CD                                                                       -
CD  2   7-12      ABSOLUTE ISOTOPE LABEL                                 -
CD                                                                       -
CD  3   13-24     NUMBER OF KG IN THE CORE AT THE BEGINNING OF           -
CD                EQUILIBRIUM CYCLE FOR THE ISOTOPE IN COLS. 7-12        -
CD                                                                       -
CD  4   25-36     NUMBER OF KG IN THE AXIAL BLANKET AT THE BEGINNING OF  -
CD                EQUILIBRIUM CYCLE FOR THE ISOTOPE IN COLS. 7-12        -
CD                                                                       -
CD  5   37-48     NUMBER OF KG IN THE RADIAL BLANKET AT THE BEGINNING OF -
CD                EQUILIBRIUM CYCLE FOR THE ISOTOPE IN COLS. 7-12        -
CD                                                                       -
CD  6   49-60     NUMBER OF KG IN THE INTERNAL BLANKET AT THE BEGINNING  -
CD                EQUILIBRIUM CYCLE FOR THE ISOTOPE IN COLS. 7-12        -
CD                                                                       -
CD  7   61-72     NUMBER OF KG IN THE OUTER RADIAL BLANKET AT THE        -
CD                BEGINNING OF EQUILIBRIUM CYCLE FOR THE ISOTOPE IN COLS.-
CD                7-12                                                   -
```

```
C                                                                       -
CN              LABELS GIVEN IN COLS. 7-12 ON THE TYPE 09 CARDS MUST    -
CN              CORRESPOND TO LABELS SUPPLIED ON THE TYPE 02 CARDS OR   -
CN              TO ONE OF THE STANDARD LABELS (SEE CARD TYPE 02).  NOTE-
CN              THAT AT THIS TIME, THE MASS FLOW SUMMARY WILL EDIT DATA-
CN              ONLY FOR ISOTOPES 1-7, AND 10-14.                       -
C                                                                       -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
C                                                                       -
CR            END OF EQUILIBRIUM CYCLE MASSES (TYPE 10)                 -
C                                                                       -
CL    FORMAT-----(I2,4X,A6,5E12.6)                                      -
C                                                                       -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY               -
CD  =  ======  =========================================================-
CD  1  1-2     10                                                       -
CD                                                                      -
CD  2  7-12    ABSOLUTE ISOTOPE LABEL                                   -
CD                                                                      -
CD  3  13-24   NUMBER OF KG IN THE CORE AT THE END OF                   -
CD             EQUILIBRIUM CYCLE FOR THE ISOTOPE IN COLS. 7-12          -
CD                                                                      -
CD  4  25-36   NUMBER OF KG IN THE AXIAL BLANKET AT THE END OF          -
CD             EQUILIBRIUM CYCLE FOR THE ISOTOPE IN COLS. 7-12          -
CD                                                                      -
CD  5  37-48   NUMBER OF KG IN THE RADIAL BLANKET AT THE END OF         -
CD             EQUILIBRIUM CYCLE FOR THE ISOTOPE IN COLS. 7-12          -
CD                                                                      -
CD  6  49-60   NUMBER OF KG IN THE INTERNAL BLANKET AT THE END OF       -
CD             EQUILIBRIUM CYCLE FOR THE ISOTOPE IN COLS. 7-12          -
CD                                                                      -
CD  7  61-72   NUMBER OF KG IN THE OUTER RADIAL BLANKET AT THE          -
CD             END OF EQUILIBRIUM CYCLE FOR THE ISOTOPE IN COLS. 7-12 -
C                                                                       -
CN              LABELS GIVEN IN COLS. 7-12 ON THE TYPE 10 CARDS MUST    -
CN              CORRESPOND TO LABELS SUPPLIED ON THE TYPE 02 CARDS OR   -
CN              TO ONE OF THE STANDARD LABELS (SEE CARD TYPE 02).  NOTE-
CN              THAT AT THIS TIME, THE MASS FLOW SUMMARY WILL EDIT DATA-
CN              ONLY FOR ISOTOPES 1-7, AND 10-14.                       -
C                                                                       -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
C                                                                       -
CR            CORE FEED SPECIFICATIONS (TYPE 11)                        -
C                                                                       -
CL    FORMAT-----(I2,4X,3(A6,E12.6))                                    -
C                                                                       -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY               -
CD  =  ======  =========================================================-
CD  1  1-2     11                                                       -
CD                                                                      -
CD  2  7-12    ABSOLUTE ISOTOPE LABEL                                   -
CD                                                                      -
CD  3  13-24   NUMBER OF KG OF CORE FEED AT THE BEGINNING OF            -
CD             EQUILIBRIUM CYCLE FOR THE ISOTOPE IN COLS. 7-12          -
CD                                                                      -
CD  4  25-20   ABSOLUTE ISOTOPE LABEL                                   -
CD                                                                      -
CD  5  31-42   NUMBER OF KG OF CORE FEED AT THE BEGINNING OF            -
CD             EQUILIBRIUM CYCLE FOR THE ISOTOPE IN COLS. 25-30         -
CD                                                                      -
CD  6  43-48   ABSOLUTE ISOTOPE LABEL                                   -
CD                                                                      -
CD  7  49-60   NUMBER OF KG OF CORE FEED AT THE BEGINNING OF            -
CD             EQUILIBRIUM CYCLE FOR THE ISOTOPE IN COLS. 43-48         -
C                                                                       -
CN              LABELS GIVEN IN COLS. 7-12, 25-30, AND 43-48 ON THE     -
```

```
CN              TYPE 11 CARDS MUST CORRESPOND TO LABELS SUPPLIED ON THE-
CN              TYPE 02 CARDS OR TO ONE OF THE STANDARD LABELS (SEE    -
CN              CARD TYPE 02).  NOTE THAT AT THIS TIME, THE MASS FLOW  -
CN              SUMMARY WILL EDIT DATA ONLY FOR ISOTOPES 1-7, AND      -
CN              10-14.                                                 -
C                                                                      -
C----------------------------------------------------------------------

CEOF
```

```
C*******************************************************************-
C                                                                   -
C                      PREPARED 8/28/75 AT ANL                      -
C                      LAST REVISED 12/20/01                        -
C                                                                   -
CF          A.NIP3                                                  -
CE          NEUTRONICS MODEL INPUT FOR CODES WHICH REQUIRE CCCC     -
CE          INTERFACE FILES                                         -
C                                                                   -
CN                      THIS BCD DATA SET MAY BE WRITTEN EITHER     -
CN                      IN FREE FORMAT (UNFORM=A.NIP3) OR ACCORDING TO -
CN                      THE FORMATS SPECIFIED FOR EACH CARD TYPE    -
CN                      (DATASET=A.NIP3).                           -
CN                                                                  -
CN                      COLUMNS 1-2 MUST CONTAIN THE CARD TYPE      -
CN                      NUMBER.                                     -
CN                                                                  -
CN                      UNLESS OTHERWISE STATED, BLANKS ARE NOT     -
CN                      MEANINGFUL IN A6 LABEL FIELDS.              -
C                                                                   -
C                                                                   -
CN              ***  CARD TYPE DIRECTORY  ***                       -
CN                                                                  -
CN     TYPE                  CONTENTS                               -
CN     ====     ======================================================= -
CN      01      PROBLEM TITLE                                       -
CN      02      INPUT PROCESSING SPECIFICATIONS                     -
CN      03      PROBLEM GEOMETRY                                    -
CN      04      EXTERNAL BOUNDARY CONDITIONS                        -
CN      05      EXTERNAL BOUNDARY CONDITION CONSTANTS               -
CN      06      REGION BOUNDARIES FOR ORTHOGONAL GEOMETRIES         -
CN      07      AREA SPECIFICATIONS                                 -
CN      09      VARIABLE-MESH STRUCTURE                             -
CN      10      INTERNAL BLACK ABSORBER CONDITIONS                  -
CN      11      INTERNAL BLACK ABSORBER CONDITION CONSTANTS         -
CN      12      FINITE-GEOMETRY TRANSVERSE DISTANCES                -
CN      13      MATERIAL SPECIFICATIONS                             -
CN      14      COMPOSITION (ZONE) SPECIFICATIONS                   -
CN      15      REGION/COMPOSITION CORRESPONDENCE                   -
CN      19      REGION OR MESH DISTRIBUTED INHOMOGENEOUS SOURCE     -
CN      21      SEARCH EDIT OPTIONS AND CONVERGENCE CRITERIA        -
CN      22      SEARCH PARAMETER DATA                               -
CN      23      CONCENTRATION MODIFIERS FOR CRITICALITY SEARCH      -
CN      24      MESH MODIFIERS FOR CRITICALITY SEARCH               -
CN      25      BUCKLING MODIFIERS FOR CRITICALITY SEARCH           -
CN      26      ALPHA MODIFIERS FOR CRITICALITY SEARCH              -
CN      29      HEXAGON DIMENSION                                   -
CN      30      REGION DEFINITIONS FOR ARRAYS OF HEXAGONS           -
CN      31      BACKGROUND REGION FOR ARRAYS OF HEXAGONS            -
CN      34      COMPOSITION- AND GROUP-DEPENDENT BUCKLINGS          -
CN      35      DIRECTIONAL DIFFUSION COEF. SCHEME                  -
CN      36      DIRECTIONAL DIFFUSION COEF./COMPOSITION CORRESPONDENCE -
CN      37      FISSION ENERGY CONVERSION FACTORS                  -
CN      38      CAPTURE ENERGY CONVERSION FACTORS                  -
CN      39      NUCLIDE SET ASSIGNMENTS                             -
CN      40      SOURCE EDIT, SYNTHESIS TRIAL FUNCTION SOURCE        -
CN      41      NATURAL DECAY INHOMOGENEOUS SOURCE                  -
CN      42      SOURCE SPECTRA                                      -
CN      43      GRAPHICS OUTPUT CONTROL                             -
CN      44      ASSIGNMENT OF REGION TO CONTROL ROD BANK            -
C                                                                   -
C*******************************************************************-


C-------------------------------------------------------------------
CR          PROBLEM TITLE (TYPE 01)                                 -
C                                                                   -
CL    FORMAT-----(I2,4X,11A6)                                       -
C                                                                   -
CD    COLUMNS          CONTENTS...IMPLICATIONS, IF ANY              -
CD    =======  =======================================================-
CD     1-2     01                                                   -
```

```
CD                                                                      -
CD      7-72     ANY ALPHANUMERIC CHARACTERS.                           -
C                                                                       -
CN                ANY NUMBER OF TYPE 01 CARDS MAY BE USED (ONLY FIRST   -
CN                SIX PRINTED BY REBUS).                                 -
C                                                                       -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR            INPUT PROCESSING SPECIFICATION (TYPE 02)                  -
C                                                                       -
CL    FORMAT-----(I2,10X,8I6)                                           -
C                                                                       -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY                 -
CD  =  =======  =======================================================-
CD  1  1-2      02                                                      -
CD                                                                      -
CD  2  13-18    POINTR DEBUGGING EDIT FOR GEOMETRY PROCESSING MODULE.   -
CD             0...NO DEBUGGING PRINTOUT (DEFAULT).                     -
CD             1...DEBUGGING DUMP PRINTOUT.                             -
CD             2...DEBUGGING TRACE PRINTOUT.                            -
CD             3...FULL DEBUGGING PRINTOUT (DUMP+TRACE).                -
CD                                                                      -
CD  3  19-24    GEOMETRY PROCESSING MODULE EDIT.                        -
CD             0...NO EDITS (DEFAULT).                                  -
CD             1...PRINT GEOMETRY EDITS.                                -
CD             2...WRITE GEOMETRY EDITS TO AUXILIARY OUTPUT FILE.       -
CD             3...GEOMETRY EDITS GO TO BOTH PRINT AND AUXILIARY        -
CD                 OUTPUT FILES.                                        -
CD                                                                      -
CD             OPTIONS 2 AND 3 ARE OPERATIVE ONLY FOR THOSE CODES       -
CD             WHICH RECOGNIZE AUXILIARY OUTPUT FILES.                  -
CD                                                                      -
CD  4  25-30    SIZE OF MAIN CORE STORAGE ARRAY FOR GEOMETRY            -
CD             PROCESSING MODULE (GNIP4C) IN REAL*8 WORDS               -
CD             (DEFAULT=10000).                                         -
CD                                                                      -
CD  5  31-36    SIZE OF BULK CORE STORAGE ARRAY FOR GEOMETRY            -
CD             PROCESSING MODULE (GNIP4C) IN REAL*8 WORDS               -
CD             (DEFAULT=0).                                             -
CD                                                                      -
CD  6  37-42    SIZE OF MAIN CORE STORAGE ARRAY FOR CROSS SECTION       -
CD             PROCESSING MODULES IN REAL*8 WORDS (DEFAULT = 20000).    -
CD                                                                      -
CD  7  43-48    SIZE OF BULK CORE STORAGE ARRAY FOR CROSS SECTION       -
CD             PROCESSING MODULES IN REAL*8 WORDS (DEFAULT=0).          -
CD                                                                      -
CD  8  49-54    POINTR DEBUGGING EDIT FOR CROSS SECTION PROCESSING      -
CD             MODULES.                                                 -
CD             0...NO DEBUGGING PRINTOUT (DEFAULT).                     -
CD             1...DEBUGGING DUMP PRINTOUT.                             -
CD             2...DEBUGGING TRACE PRINTOUT.                            -
CD             3...FULL DEBUGGING PRINTOUT (DUMP+TRACE).                -
CD                                                                      -
CD  9  55-60    CROSS SECTION PROCESSING EDIT.                          -
CD             0...NO EDITS (DEFAULT).                                  -
CD             1...PRINT CROSS SECTION EDITS.                           -
CD             2...WRITE CROSS SECTION EDITS TO AUXILIARY OUTPUT FILE.- 
CD             3...CROSS SECTION EDITS GO TO BOTH PRINT AND AUXILIARY - 
CD                 OUTPUT FILES.                                        -
CN             IF NO DATASET A.HMG4C, THIS FLAG CONTROLS EDIT OF FILE - 
CN             COMPXS.                                                  -
CD                                                                      -
CD 10  61-66    REGION/MESH INTERVAL PRINTER-PLOTTER MAP EDIT DURING    -
CD             GEOMETRY PROCESSING.                                     -
CD             0...NO MAP (DEFAULT).                                    -
CD             1...PRINT REGION MAP.                                    -
CD             2...WRITE REGION MAP TO AUXILIARY OUTPUT FILE.           -
CD             3...WRITE REGION MAP TO BOTH PRINT AND AUXILIARY OUTPUT- 
CD                 FILES.                                               -
CD                                                                      -
```

```
CD  11  67-72    ZONE(COMPOSITION)/MESH INTERVAL PRINTER-PLOTTER MAP   -
CD               EDIT DURING GEOMETRY PROCESSING.                      -
CD               0...NO MAP (DEFAULT).                                 -
CD               1...PRINT ZONE MAP.                                   -
CD               2...WRITE ZONE MAP TO AUXILIARY OUTPUT FILE.          -
CD               3...WRITE ZONE MAP TO BOTH PRINT AND AUXILIARY OUTPUT -
CD                   FILES.                                            -
CD                                                                     -
CN               EDIT OPTIONS 2 AND 3 ARE OPERATIVE ONLY FOR THOSE     -
CN               CODES WHICH RECOGNIZE AUXILIARY OUTPUT FILES.         -
CN                                                                     -
CN               THE PRINTER-PLOTTER MAP OPTIONS (COLS. 61-72) ARE     -
CN               ENTIRELY SEPARATE FROM THE GRAPHICS MAP OPTIONS       -
CN               IN COLS. 7-48 OF THE TYPE 43 CARD.                    -
C                                                                      -
C----------------------------------------------------------------------


C----------------------------------------------------------------------
CR            PROBLEM GEOMETRY SPECIFICATION (TYPE 03)                 -
C                                                                      -
CL     FORMAT-----(I2,10X,I6)                                          -
C                                                                      -
CD  #   COLUMNS           CONTENTS...IMPLICATIONS, IF ANY.             -
CD  =   =======   ========================================================-
CD  1   1-2       03                                                   -
CD                                                                     -
CD  2   13-18     GEOMETRY TYPE.                                       -
CD                10...SLAB                                            -
CD                20...CYLINDER                                        -
CD                30...SPHERE                                          -
CD                40...X-Y                                             -
CD                44...X-Y-Z                                           -
CD                50...R-Z                                             -
CD                60...R-THETA                                         -
CD                62...R-THETA-Z                                       -
CD                64...THETA-R                                         -
CD                66...THETA-R-Z                                       -
CD                70...TRIANGULAR, RHOMBIC BOUNDARY, CORE CENTER AT    -
CD                    60 DEGREE ANGLE (SIXTH CORE SYMMETRY).           -
CD                72...TRIANGULAR, RECTANGULAR BOUNDARY, HALF CORE     -
CD                    SYMMETRY.                                        -
CD                74...TRIANGULAR, RHOMBIC BOUNDARY, CORE CENTER AT    -
CD                    120 DEGREE ANGLE (THIRD CORE SYMMETRY).          -
CD                76...TRIANGULAR, 60 DEGREE TRIANGULAR BOUNDARY,      -
CD                    SIXTH CORE SYMMETRY.                             -
CD                78...TRIANGULAR, RECTANGULAR BOUNDARY, QUARTER       -
CD                    CORE SYMMETRY.                                   -
CD                80...TRIANGULAR, RECTANGULAR BOUNDARY, FULL CORE.    -
CD                90...TRIANGULAR-Z, RHOMBIC BOUNDARY IN PLANE, CORE   -
CD                    CENTER LINE AT 60 DEGREE ANGLE.                  -
CD                92...TRIANGULAR-Z, RECTANGULAR BOUNDARY IN PLANE,    -
CD                    HALF CORE SYMMETRY IN PLANE.                     -
CD                94...TRIANGULAR-Z, RHOMBIC BOUNDARY IN PLANE, CORE   -
CD                    CENTER LINE AT 120 DEGREE ANGLE.                 -
CD                96...TRIANGULAR-Z, 60 DEGREE TRIANGULAR BOUNDARY     -
CD                    IN PLANE.                                        -
CD                98...TRIANGULAR-Z, RECTANGULAR BOUNDARY IN PLANE,    -
CD                    QUARTER CORE SYMMETRY IN PLANE.                  -
CD               100...TRIANGULAR-Z, RECTANGULAR BOUNDARY IN PLANE,    -
CD                    FULL CORE IN PLANE.                              -
CD               110...HEXAGONAL, FULL CORE.                           -
CD               114...HEXAGONAL, SIXTH CORE SYMMETRY.                 -
CD               116...HEXAGONAL, THIRD CORE SYMMETRY.                 -
CD               120...HEXAGONAL-Z, FULL CORE IN PLANE.                -
CD               124...HEXAGONAL-Z, SIXTH CORE SYMMETRY IN PLANE.      -
CD               126...HEXAGONAL-Z, THIRD CORE SYMMETRY IN PLANE.      -
CD                                                                     -
C                                                                      -
C                                                                      -
C----------------------------------------------------------------------
```

```
C------------------------------------------------------------------------
CR          EXTERNAL BOUNDARY CONDITIONS (TYPE 04)                    -
C                                                                        -
CL     FORMAT-----(I2,10X,616)                                         -
C                                                                        -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY               -
CD  =  =======  ========================================================-
CD  1  1-2      04                                                     -
CD                                                                       -
CD  2  13-18    BOUNDARY CONDITION AT LOWER "X" BOUNDARY OF REACTOR.   -
CD                                                                       -
CD  3  19-24    BOUNDARY CONDITION AT UPPER "X" BOUNDARY OF REACTOR.   -
CD                                                                       -
CD  4  25-30    BOUNDARY CONDITION AT LOWER "Y" BOUNDARY OF REACTOR.   -
CD                                                                       -
CD  5  31-36    BOUNDARY CONDITION AT UPPER "Y" BOUNDARY OF REACTOR.   -
CD                                                                       -
CD  6  37-42    BOUNDARY CONDITION AT LOWER Z BOUNDARY OF REACTOR.     -
CD                                                                       -
CD  7  43-48    BOUNDARY CONDITION AT UPPER Z BOUNDARY OF REACTOR.     -
CD                                                                       -
CD                                                                       -
CD              2...PHI=0.                                             -
CD              3...PHI PRIME=0.                                       -
CD              4...D * PHI PRIME + A * PHI = 0.                       -
CD              6...REPEATING (PERIODIC) WITH OPPOSITE FACE.           -
CD              7...REPEATING (PERIODIC) WITH NEXT ADJACENT BOUNDARY   -
CD                 (SEE DISCUSSION BELOW).                             -
CD              8...INVERTED REPEATING ALONG THIS FACE                 -
CD                 (180 DEGREE ROTATION).                              -
CD              9...INCOMING ANGULAR FLUX ZERO (TRANSPORT ONLY).       -
CD              10..REFLECTIVE (TRANSPORT ONLY).                       -
CD              11..PERIODIC (TRANSPORT ONLY).                         -
CD              12..WHITE (TRANSPORT ONLY).                            -
CD                                                                       -
C                                                                        -
CN              PHI PRIME IS THE DERIVATIVE OF THE FLUX IN THE         -
CN              DIRECTION OF THE REACTOR OUTWARD NORMAL. D IS THE      -
CN              DIFFUSION COEFFICIENT IN THE MESH INTERVAL             -
CN              IMMEDIATELY INSIDE THE REACTOR BOUNDARY. IF COLS.      -
CN              43-48 ARE 4 AND NO TYPE 05 CARD IS SUPPLIED TO SPECIFY -
CN              THE CONSTANT A, THE VALUE 0.46920 WILL BE USED BY      -
CN              DEFAULT.                                               -
CN                                                                       -
CN              CONDITIONS 2-8 APPLY TO DIFFUSION THEORY PROBLEMS,     -
CN              AND 9-12 APPLY TO TRANSPORT THEORY PROBLEMS.           -
CN                                                                       -
CN              "X" REPRESENTS THE FIRST DIMENSION COORDINATE (X IN    -
CN              X-Y GEOMETRY, R IN R-Z, ETC.). "Y" REPRESENTS THE      -
CN              SECOND DIMENSION COORDINATE (Y IN X-Y GEOMETRY, Z IN   -
CN              R-Z, ETC.). WHEN THE MODEL IS THREE-DIMENSIONAL, THE   -
CN              THIRD DIMENSION IS ALWAYS Z.                           -
CN                                                                       -
CN              REPEATING CONDITIONS (6,7,8) ARE ONLY APPLICABLE TO    -
CN              THE FIRST TWO DIMENSIONS.                              -
CN                                                                       -
CN              NOTE FOR REPEATING CONDITION 7.  LET XL DENOTE THE     -
CN              LOWER "X" BOUNDARY, XU DENOTE THE UPPER "X" BOUNDARY,  -
CN              YL DENOTE THE LOWER "Y" BOUNDARY AND YU DENOTE THE     -
CN              UPPER Y BOUNDARY.  FOR REPEATING BOUNDARY CONDITIONS   -
CN              (CONDITION 7), THE SEQUENCE OF BOUNDARIES IMPLIED BY   -
CN              THE TERM "NEXT ADJACENT BOUNDARY" IS XL, YL, XU, YU.   -
CN              OF THE TWO BOUNDARIES INVOLVED, THE ONE APPEARING      -
CN              FIRST IN THE SEQUENCE IS ASSIGNED THE BOUNDARY         -
CN              CONDITION (7), THE SECOND IS IGNORED.  FOR EXAMPLE,    -
CN              IF XL AND YL ARE THE PERIODIC BOUNDARIES, COLS. 13-18  -
CN              MUST CONTAIN A 7, COLS. 25-30 WILL BE IGNORED.         -
C                                                                        -
C------------------------------------------------------------------------
```

```
C-------------------------------------------------------------------------
CR           EXTERNAL BOUNDARY CONDITION CONSTANTS (TYPE 05)          -
C                                                                         -
CL     FORMAT-----(I2,8X,A2,E12.5,12X,2I6)                               -
C                                                                         -
CD  #  COLUMNS     CONTENTS...IMPLICATIONS, IF ANY                       -
CD  =  =======  =========================================================-
CD  1  1-2       05                                                      -
CD                                                                        -
CD  2  11-12     BOUNDARY DESIGNATOR.                                    -
CD               XL..."X" LOWER.                                         -
CD               XU..."X" UPPER.                                         -
CD               YL..."Y" LOWER.                                         -
CD               YU..."Y" UPPER.                                         -
CD               ZL...Z LOWER.                                           -
CD               ZU...Z UPPER.                                           -
CD                                                                        -
CD  3  13-24     VALUE OF CONSTANT A REFERRED TO ON CARD TYPE 04.        -
CD                                                                        -
CD  4  37-42     HIGHER-ENERGY GROUP NUMBER FOR WHICH CONSTANTS APPLY.   -
CD                                                                        -
CD  5  43-48     LOWER-ENERGY GROUP NUMBER FOR WHICH CONSTANTS APPLY.    -
C                                                                         -
CN               AS MANY TYPE 05 CARDS AS NECESSARY MAY BE USED TO       -
CN               SPECIFY THE EXTERNAL BOUNDARY CONDITIONS.               -
CN                                                                        -
CN               IF NO "HIGHER-ENERGY GROUP NUMBER" IS SUPPLIED (COLS.   -
CN               37-42 ARE BLANK), THE CONSTANTS GIVEN APPLY TO ALL      -
CN               ENERGY GROUPS. IF NO "LOWER-ENERGY GROUP NUMBER" IS     -
CN               SUPPLIED (COLS. 43-48 ARE BLANK), THE CONSTANTS GIVEN   -
CN               APPLY TO THE "HIGHER-ENERGY GROUP" ONLY. IF NO GROUP    -
CN               NUMBERS ARE SUPPLIED (COLS. 37-48 ARE BLANK), THE       -
CN               CONSTANTS GIVEN APPLY TO ALL ENERGY GROUPS.             -
CN                                                                        -
CN               DATA ON THIS CARD MAY BE OVERLAYED. THAT IS, BOUNDARY   -
CN               CONSTANTS DEFINED ON LATER TYPE 5 CARDS SUPERSEDE DATA  -
CN               FOR ENERGY RANGES PREVIOUSLY SPECIFIED.                 -
CN                                                                        -
CN               "X" REPRESENTS THE FIRST DIMENSION COORDINATE (X IN     -
CN               X-Y GEOMETRY, R IN R-Z, ETC.). "Y" REPRESENTS THE       -
CN               SECOND DIMENSION COORDINATE (Y IN X-Y GEOMETRY, Z IN    -
CN               R-Z, ETC.). WHEN THE MODEL IS THREE-DIMENSIONAL, THE    -
CN               THIRD DIMENSION IS ALWAYS Z.                            -
C                                                                         -
C-------------------------------------------------------------------------


C-------------------------------------------------------------------------
CR         REGION BOUNDARY COORDINATES AND CONSTANT MESH STRUCTURE   -
CR         (TYPE 06)                                                  -
C                                                                         -
CL     FORMAT-----(I2,4X,A6,2E12.5,2I6,2E12.5)                          -
C                                                                         -
CD  #  COLUMNS        CONTENTS...IMPLICATIONS, IF ANY                    -
CD  =  =======  =========================================================-
CD  1  1-2       06                                                      -
CD                                                                        -
CD  2  7-12      REGION LABEL (REPEATED ON ADDITIONAL TYPE 06 CARDS).    -
CD                                                                        -
CD  3  13-24     "X"-DIRECTION LOWER-BOUNDARY COORDINATE.               -
CD                                                                        -
CD  4  25-36     "X"-DIRECTION UPPER-BOUNDARY COORDINATE.               -
CD                                                                        -
CD  5  37-42     FOR ONE-DIMENSIONAL AND TWO-DIMENSIONAL GEOMETRIES,    -
CD               NUMBER OF INTERVALS IN "X"-DIRECTION.                  -
CD                                                                        -
CD                                ** OR **                              -
CD                                                                        -
CD               FOR THREE-DIMENSIONAL GEOMETRIES, LOWER Z MESH         -
CD               LINE NUMBER OF THE REGION.                             -
CD                                                                        -
CD  6  43-48     FOR TWO-DIMENSIONAL GEOMETRIES, NUMBER OF INTERVALS    -
```

```
CD                IN "Y"-DIRECTION.                                      -
CD                                                                       -
CD                              ** OR **                                 -
CD                                                                       -
CD                FOR THREE-DIMENSIONAL GEOMETRIES, UPPER Z MESH         -
CD                LINE NUMBER OF THE REGION.                             -
CD                                                                       -
CD  7   49-60    "Y"-DIRECTION LOWER-BOUNDARY COORDINATE.               -
CD                                                                       -
CD  8   61-72    "Y"-DIRECTION UPPER-BOUNDARY COORDINATE.               -
C                                                                        -
CN                CARD TYPE 06 IS NOT PERTINENT FOR TRIANGULAR,          -
CN                TRIANGULAR-Z, HEXAGONAL, OR HEXAGONAL-Z GEOMETRIES.    -
CN                SEE CARD TYPE 30.                                      -
CN                                                                       -
CN                "X" REPRESENTS THE FIRST DIMENSION COORDINATE (X IN    -
CN                X-Y GEOMETRY, R IN R-Z, ETC.). "Y" REPRESENTS THE      -
CN                SECOND DIMENSION COORDINATE (Y IN X-Y GEOMETRY, Z IN   -
CN                R-Z, ETC.). WHEN THE MODEL IS THREE-DIMENSIONAL, THE   -
CN                THIRD DIMENSION IS ALWAYS Z.                           -
C                                                                        -
CN                IN GEOMETRIES INVOLVING AN ANGULAR DIMENSION (THETA)   -
CN                THE ANGULAR VARIABLE MUST BE GIVEN IN RADIANS.         -
CN                                                                       -
CN                REGIONS MAY BE DEFINED USING THE OVERLAY PRECEDURE,    -
CN                WITH THE LATEST REGION ASSIGNMENT OVERLAYING THE       -
CN                PREVIOUS CONFIGURATION, OR USING THE USUAL PROCEDURE,  -
CN                WITH EACH REGION'S BOUNDARIES GIVEN EXPLICITLY.        -
CN                REGION LABELS MUST BE NON-BLANK.                       -
CN                                                                       -
CN                THE MESH FOR A DIRECTION MUST BE COMPLETELY SPECIFIED  -
CN                EITHER ON THE TYPE 06 OR 09 CARDS. IF MESH DATA ARE    -
CN                SUPPLIED ON BOTH TYPE 06 AND 09 CARDS, THE TYPE 09     -
CN                DATA WILL BE USED.                                     -
CN                                                                       -
CN                FOR ONE-DIMENSIONAL PROBLEMS, ONLY THE "X"-DIRECTION   -
CN                UPPER BOUNDARIES NEED BE GIVEN FOR REGIONS AFTER THE   -
CN                FIRST.  IF THIS OPTION IS USED THE TYPE 6 CARDS MUST   -
CN                BE ARRANGED SO AS TO DEFINE REGIONS SEQUENTIALLY,      -
CN                MOVING FROM LEFT TO RIGHT.  IN OTHER WORDS THE         -
CN                X-DIRECTION UPPER BOUNDARIES MUST BE IN ASCENDING      -
CN                ORDER.                                                 -
CN                                                                       -
CN                FOR THREE-DIMENSIONAL GEOMETRIES, THE DEFINITION OF    -
CN                THE MESH STRUCTURE MUST BE SUPPLIED ON TYPE 09 CARDS.  -
CN                                                                       -
CN                THE LOWEST Z MESH LINE NUMBER (CORRESPONDING TO THE    -
CN                FIRST Z BOUNDARY) OF THE MODEL IS 0 (ZERO). THE        -
CN                LARGEST Z MESH LINE NUMBER (CORRESPONDING TO THE       -
CN                SECOND Z BOUNDARY) IS EQUAL TO THE NUMBER OF Z MESH    -
CN                INTERVALS.                                             -
C                                                                        -
C------------------------------------------------------------------------
```

```
C------------------------------------------------------------------------
CR          AREA SPECIFICATIONS (TYPE 07)                               -
C                                                                        -
CL    FORMAT-----(I2,4X,11A6)                                           -
C                                                                        -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY                 -
CD  =  =======  ========================================================-
CD  1  1-2      07                                                      -
CD                                                                       -
CD  2  7-12     AREA LABEL (REPEATED ON ADDITIONAL TYPE 07 CARDS).      -
CD                                                                       -
CD  3  13-18    LABEL OF REGION COMPRISING AREA.                        -
CD                                                                       -
CD  4  19-24    LABEL OF REGION COMPRISING AREA.                        -
CD                                                                       -
CD  5  25-30    LABEL OF REGION COMPRISING AREA.                        -
CD                                                                       -
```

```
CD   6   31-36    LABEL OF REGION COMPRISING AREA.               -
CD                                                               -
CD   7   37-42    LABEL OF REGION COMPRISING AREA.               -
CD                                                               -
CD   8   43-48    LABEL OF REGION COMPRISING AREA.               -
CD                                                               -
CD   9   49-54    LABEL OF REGION COMPRISING AREA.               -
CD                                                               -
CD  10   55-60    LABEL OF REGION COMPRISING AREA.               -
CD                                                               -
CD  11   61-66    LABEL OF REGION COMPRISING AREA.               -
CD                                                               -
CD  12   67-72    LABEL OF REGION COMPRISING AREA.               -
C                                                                -
CN                AREA LABELS MUST BE NON-BLANK. THE FIRST BLANK REGION  -
CN                LABEL ENCOUNTERED TERMINATES READING OF THE DATA ON    -
CN                THAT PARTICULAR TYPE 07 CARD. A REGION CAN BE PLACED    -
CN                IN AS MANY AREAS AS THE USER DESIRES.                   -
CN                                                                -
CN                THE CONCEPT OF AREAS DOES NOT EXIST IN THE CCCC  -
CN                ENVIRONMENT. ONLY CERTAIN CODES WRITTEN AT ANL MAKE  -
CN                USE OF AREAS, AND IN THOSE CODES AREAS ARE USED FOR  -
CN                EDIT PURPOSES ONLY.                             -
C                                                                -
C----------------------------------------------------------------------


C----------------------------------------------------------------------
CR          VARIABLE-MESH STRUCTURE (TYPE 09)                    -
C                                                                -
CL    FORMAT-----(I2,9X,A1,3(I6,E12.5))                          -
C                                                                -
CD   #   COLUMNS          CONTENTS...IMPLICATIONS, IF ANY         -
CD   =   =======  ========================================================-
CD   1   1-2      09                                             -
CD                                                               -
CD   2   12       COORDINATE DIRECTION.                          -
CD                X..."X" COORDINATE DIRECTION.                  -
CD                Y..."Y" COORDINATE DIRECTION.                  -
CD                Z...Z-COORDINATE DIRECTION.                    -
CD                                                               -
CD   3   13-18    NUMBER OF INTERVALS.                           -
CD                                                               -
CD   4   19-30    UPPER COORDINATE.                              -
CD                                                               -
CD   5   31-36    NUMBER OF INTERVALS.                           -
CD                                                               -
CD   6   37-48    UPPER COORDINATE.                              -
CD                                                               -
CD   7   49-54    NUMBER OF INTERVALS.                           -
CD                                                               -
CD   8   55-66    UPPER COORDINATE.                              -
C                                                                -
CN                NOTE THAT A Z IN COL. 12 IS PERTINENT ONLY IF THE  -
CN                GEOMETRY IS THREE-DIMENSIONAL.                 -
CN                                                               -
CN                "X" REPRESENTS THE FIRST DIMENSION COORDINATE (X IN  -
CN                X-Y GEOMETRY, R IN R-Z, ETC.). "Y" REPRESENTS THE  -
CN                SECOND DIMENSION COORDINATE (Y IN X-Y GEOMETRY, Z IN  -
CN                R-Z, ETC.). WHEN THE MODEL IS THREE-DIMENSIONAL, THE  -
CN                THIRD DIMENSION IS ALWAYS Z.                   -
C                                                                -
CN                IN GEOMETRIES INVOLVING AN ANGULAR DIMENSION (THETA)  -
CN                THE ANGULAR VARIABLE MUST BE GIVEN IN RADIANS.  -
CN                                                               -
CN                EACH NUMBER PAIR IS OF THE FORM (N(I), X(I)). THERE  -
CN                ARE N(I) INTERVALS BETWEEN X(I-1) AND X(I), WHERE X(0)  -
CN                IS THE LOWER REACTOR BOUNDARY IN THIS DIRECTION.  -
CN                NUMBER PAIRS MUST BE GIVEN IN ORDER OF INCREASING  -
CN                MESH COORDINATES. ALL REGION BOUNDARIES MUST COINCIDE  -
CN                WITH THE MESH LINES THAT BOUND MESH INTERVALS.  -
C                                                                -
```

```
C----------------------------------------------------------------------

C----------------------------------------------------------------------
CR            INTERNAL BLACK ABSORBER CONDITIONS (TYPE 10)           -
C                                                                    -
CL     FORMAT-----(I2,10X,10A6)                                      -
C                                                                    -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY             -
CD  =  =======  ========================================================-
CD  1  1-2      10                                                   -
CD                                                                   -
CD  2  13-18    LABEL OF COMPOSITION (CCCC ZONE) WHICH IS TO BE      -
CD              TREATED WITH INTERNAL BLACK BOUNDARY CONDITION.      -
CD                                                                   -
CD  3  19-24    LABEL OF COMPOSITION (CCCC ZONE) WHICH IS TO BE      -
CD              TREATED WITH INTERNAL BLACK BOUNDARY CONDITION.      -
CD                                                                   -
CD  4  25-30    LABEL OF COMPOSITION (CCCC ZONE) WHICH IS TO BE      -
CD              TREATED WITH INTERNAL BLACK BOUNDARY CONDITION.      -
CD                                                                   -
CD  5  31-36    LABEL OF COMPOSITION (CCCC ZONE) WHICH IS TO BE      -
CD              TREATED WITH INTERNAL BLACK BOUNDARY CONDITION.      -
CD                                                                   -
CD  6  37-42    LABEL OF COMPOSITION (CCCC ZONE) WHICH IS TO BE      -
CD              TREATED WITH INTERNAL BLACK BOUNDARY CONDITION.      -
CD                                                                   -
CD  7  43-48    LABEL OF COMPOSITION (CCCC ZONE) WHICH IS TO BE      -
CD              TREATED WITH INTERNAL BLACK BOUNDARY CONDITION.      -
CD                                                                   -
CD  8  49-54    LABEL OF COMPOSITION (CCCC ZONE) WHICH IS TO BE      -
CD              TREATED WITH INTERNAL BLACK BOUNDARY CONDITION.      -
CD                                                                   -
CD  9  55-60    LABEL OF COMPOSITION (CCCC ZONE) WHICH IS TO BE      -
CD              TREATED WITH INTERNAL BLACK BOUNDARY CONDITION.      -
CD                                                                   -
CD 10  61-66    LABEL OF COMPOSITION (CCCC ZONE) WHICH IS TO BE      -
CD              TREATED WITH INTERNAL BLACK BOUNDARY CONDITION.      -
CD                                                                   -
CD 11  67-72    LABEL OF COMPOSITION (CCCC ZONE) WHICH IS TO BE      -
CD              TREATED WITH INTERNAL BLACK BOUNDARY CONDITION.      -
C                                                                    -
CN             AS MANY TYPE 10 CARDS CAN BE USED AS ARE NECESSARY TO -
CN             SPECIFY ALL OF THE DESIRED COMPOSITION (CCCC ZONE)    -
CN             LABELS.                                               -
CN                                                                   -
CN             EACH REGION WHICH IS COMPOSED OF ANY COMPOSITION      -
CN             LISTED ON TYPE 10 CARDS WILL BE TREATED AS A BLACK    -
CN             ABSORBER ACCORDING TO THE INTERNAL BOUNDARY CONDITIONS -
CN             GIVEN ON TYPE 11 CARDS TO FOLLOW.                     -
CN                                                                   -
CN             THE REGIONS WHICH ARE COMPRISED OF THESE COMPOSITIONS -
CN             ARE SPECIFIED ON TYPE 15 CARDS.                       -
CN                                                                   -
CN             THE FIRST BLANK COMPOSITION LABEL TERMINATES READING  -
CN             OF THE DATA ON THAT PARTICULAR TYPE 10 CARD.          -
C                                                                    -
C----------------------------------------------------------------------

C----------------------------------------------------------------------
CR            INTERNAL BLACK ABSORBER CONDITION CONSTANTS            -
CR            (TYPE 11)                                              -
C                                                                    -
CL     FORMAT-----(I2,4X,A6,2E12.5,24X,2I6)                          -
C                                                                    -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY             -
CD  =  =======  ========================================================-
CD  1  1-2      11                                                   -
CD                                                                   -
CD  2  7-12     LABEL OF COMPOSITION (CCCC ZONE) FOR WHICH CONSTANTS -
CD              APPLY.                                               -
```

```
CD                                                                    -
CD  3  13-24   THE CONSTANT A, DEFINED BELOW.                         -
CD                                                                    -
CD  4  25-36   THE CONSTANT B, DEFINED BELOW.                         -
CD                                                                    -
CD  5  61-66   HIGHER-ENERGY GROUP NUMBER FOR WHICH CONSTANTS APPLY.  -
CD                                                                    -
CD  6  67-72   LOWER-ENERGY GROUP NUMBER FOR WHICH CONSTANTS APPLY.   -
C                                                                     -
CN            THE INTERNAL BLACK BOUNDARY CONDITION IS SPECIFIED AS   -
CN                                                                    -
CN                    A*PHI PRIME + B/D*PHI = 0.                      -
CN                                                                    -
CN            IF NO "COMPOSITION LABEL" IS SUPPLIED (COLS. 7-12),     -
CN            THE CONSTANTS GIVEN APPLY TO ALL COMPOSITIONS SPECIFIED-
CN            ON THE TYPE 10 CARDS.                                   -
CN                                                                    -
CN            IF NO "HIGHER-ENERGY GROUP NUMBER" IS SUPPLIED (COLS.   -
CN            61-66 ARE BLANK), THE CONSTANTS GIVEN APPLY TO ALL      -
CN            ENERGY GROUPS. IF NO "LOWER-ENERGY GROUP NUMBER" IS     -
CN            SUPPLIED (COLS. 67-72 ARE BLANK), THE CONSTANTS GIVEN   -
CN            APPLY TO THE "HIGHER-ENERGY GROUP" ONLY. IF NO GROUP    -
CN            NUMBERS ARE SUPPLIED (COLS. 61-72 ARE BLANK), THE       -
CN            CONSTANTS GIVEN APPLY TO ALL ENERGY GROUPS.             -
CN                                                                    -
CN            DATA ON THIS CARD MAY BE OVERLAYED. THAT IS, CONSTANTS -
CN            DEFINED ON LATER TYPE 11 CARDS SUPERSEDE DATA FOR       -
CN            ENERGY RANGES PREVIOUSLY SPECIFIED.                     -
CN                                                                    -
CN            ANY GROUP FOR WHICH NO INTERNAL BLACK ABSORBER          -
CN            CONDITION CONSTANTS ARE SPECIFIED ON TYPE 11 CARDS      -
CN            WILL BE TREATED AS BEING NON-BLACK.                     -
C                                                                     -
C---------------------------------------------------------------------


C---------------------------------------------------------------------
CR           FINITE-GEOMETRY TRANSVERSE DISTANCES (TYPE 12)           -
C                                                                     -
CL    FORMAT-----(I2,4X,A6,4E12.5)                                    -
C                                                                     -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY               -
CD  =  =======  =========================================================-
CD  1  1-2      12                                                    -
CD                                                                    -
CD  2  7-12     REGION OR AREA LABEL.                                 -
CD                                                                    -
CD  3  13-24    ACTUAL TRANSVERSE HALF-HEIGHT OR RADIUS.              -
CD                                                                    -
CD  4  25-36    TRANSVERSE EXTRAPOLATION DISTANCE.                    -
CD                                                                    -
CD  5  37-48    ACTUAL TRANSVERSE HALF-HEIGHT IN THE SECOND DIRECTION -
CD              FOR A FINITE ONE-DIMENSIONAL RECTANGULAR SLAB.        -
CD                                                                    -
CD  6  49-60    TRANSVERSE EXTRAPOLATION DISTANCE IN THE SECOND       -
CD              DIRECTION FOR A FINITE ONE-DIMENSIONAL RECTANGULAR    -
CD              SLAB.                                                 -
C                                                                     -
CN            THE DATA ON THE TYPE 12 CARDS ARE USED TO CALCULATE     -
CN            REGION VOLUMES AND, IN THE ABSENCE OF TYPE 34 CARDS,    -
CN            BUCKLINGS.  REGION VOLUMES ARE CALCULATED USING         -
CN            ACTUAL HALF-HEIGHTS (EXCLUDING THE EXTRAPOLATION        -
CN            DISTANCE).                                              -
CN                                                                    -
CN            AN AREA LABEL IN COLS. 7-12 IMPLIES ALL THE REGIONS     -
CN            ASSIGNED TO THAT AREA.                                  -
CN                                                                    -
CN            THE REGION-DEPENDENT DATA THAT IS PROVIDED ON THIS      -
CN            CARD IS CONVERTED BY THE GNIP4C INPUT PROCESSOR TO      -
CN            COMPOSITION-DEPENDENT DATA.  THIS IS A POTENTIAL        -
CN            PROBLEM FOR USERS IF THEY HAVE ASSIGNED ONE             -
CN            COMPOSITION TO TWO OR MORE REGIONS WITH DIFFERENT       -
```

90

```
CN                 HALF HEIGHTS.                                        -
CN                                                                      -
CN                 IF THERE IS NO REGION LABEL (COLS.7-12 ARE BLANK), THE -
CN                 DATA ON THE CARD APPLY TO ALL REGIONS OF THE REACTOR. -
CN                 IF THERE IS NO REGION LABEL AND IF THERE ARE NO TYPE 34-
CN                 CARD (COMPOSITION AND GROUP DEPENDENT BUCKLING       -
CN                 SPECIFICATIONS), THE DATA ON THIS CARD WILL BE USED TO -
CN                 CALCULATE A SPACE- AND ENERGY-INDEPENDENT BUCKLING AND -
CN                 TO CALCULATE REGION VOLUMES. IN THIS MODE OF INPUT   -
CN                 ONLY ONE TYPE 12 CARD SHOULD BE SUPPLIED.            -
CN                                                                      -
CN                 IF MORE THAN ONE TYPE 12 CARD IS PRESENT (EACH CARD  -
CN                 WITH A VALID REGION OR AREA LABEL IN COLS. 7-12), THE -
CN                 DATA ON THE CARDS WILL BE USED TO CALCULATE REGION   -
CN                 VOLUMES.                                             -
CN                                                                      -
CN                 DATA ON THIS CARD MAY BE OVERLAYED. THAT IS,         -
CN                 TRANSVERSE DISTANCES DEFINED ON LATER TYPE 12        -
CN                 CARDS SUPERSEDE DATA FOR REGIONS PREVIOUSLY          -
CN                 SPECIFIED.                                           -
CN                                                                      -
CN                 IF TYPE 34 CARDS ARE PRESENT, BUCKLINGS WILL BE TAKEN -
CN                 FROM TYPE 34 CARDS AND WILL NOT BE CALCULATED FROM   -
CN                 TYPE 12 CARD DATA.  EVEN IF BUCKLINGS ARE TAKEN FROM -
CN                 TYPE 34 CARDS, REGION VOLUMES ARE CALCULATED USING   -
CN                 TYPE 12 CARD DATA WHEN TYPE 12 CARDS ARE PRESENT.    -
CN                                                                      -
CN                 IN THE ABSENCE OF TYPE 12 AND TYPE 34 CARDS NO       -
CN                 BUCKLINGS WILL BE USED AND REGION VOLUMES WILL BE    -
CN                 CALCULATED USING UNIT TRANSVERSE HEIGHTS.            -
C                                                                       -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR              MATERIAL SPECIFICATIONS (TYPE 13)                       -
C                                                                       -
CL     FORMAT-----(I2,10X,A6,3(A6,E12.5))                              -
C                                                                       -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY               -
CD  =  =======  =========================================================-
CD  1  1-2      13                                                      -
CD                                                                      -
CD  2  13-18    MATERIAL LABEL (REPEATED ON ADDITIONAL TYPE 13 CARDS). -
CD                                                                      -
CD  3  19-24    UNIQUE ISOTOPE LABEL.                                  -
CD                                                                      -
CD  4  25-36    ISOTOPE ATOM DENSITY (ATOMS/CC * 1.E-24).              -
CD                                                                      -
CD  5  37-42    UNIQUE ISOTOPE LABEL.                                  -
CD                                                                      -
CD  6  43-54    ISOTOPE ATOM DENSITY (ATOMS/CC * 1.E-24).              -
CD                                                                      -
CD  7  55-60    UNIQUE ISOTOPE LABEL.                                  -
CD                                                                      -
CD  8  61-72    ISOTOPE ATOM DENSITY (ATOMS/CC * 1.E-24).              -
C                                                                       -
CN                 MATERIAL LABELS MUST BE NON-BLANK.                   -
CN                                                                      -
CN                 MATERIALS CAN BE DEFINED ON A TYPE 13 CARD IN TERMS  -
CN                 OF ISOTOPES AND/OR IN TERMS OF OTHER MATERIALS. IN THE -
CN                 LATTER CASE THE "ISOTOPE LABEL" IS A MATERIAL LABEL  -
CN                 AND THE "ISOTOPE ATOM DENSITY" IS A VOLUME FRACTION. -
CN                                                                      -
CN                 THE CONCEPT OF MATERIALS DOES NOT EXIST IN THE CCCC  -
CN                 ENVIRONMENT, AND THE IDENTITY OF INDIVIDUAL MATERIALS -
CN                 IS LOST WHEN THE CCCC FILES ARE CREATED. TYPE 13     -
CN                 CARDS ARE PROVIDED AS AN INPUT CONVENIENCE ONLY.     -
C                                                                       -
CN                 VALUES LESS THAN OR EQUAL TO 1.E-20 ARE REPLACED     -
CN                 BY ZERO IN REBUS.                                    -
C                                                                       -
```

91

```
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR              COMPOSITION SPECIFICATIONS (TYPE 14)                    -
C                                                                       -
CL     FORMAT-----(I2,10X,A6,3(A6,E12.5))                               -
C                                                                       -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY                -
CD  =  =======  =========================================================-
CD  1  1-2      14                                                      -
CD                                                                      -
CD  2  13-18    COMPOSITION LABEL (REPEATED ON ADDITIONAL TYPE 14       -
CD              CARDS).                                                 -
CD                                                                      -
CD  3  19-24    MATERIAL LABEL.                                         -
CD                                                                      -
CD  4  25-36    MATERIAL VOLUME FRACTION.                               -
CD                                                                      -
CD  5  37-42    MATERIAL LABEL.                                         -
CD                                                                      -
CD  6  43-54    MATERIAL VOLUME FRACTION.                               -
CD                                                                      -
CD  7  55-60    MATERIAL LABEL.                                         -
CD                                                                      -
CD  8  61-72    MATERIAL VOLUME FRACTION.                               -
C                                                                       -
CN              COMPOSITION LABELS MUST BE NON-BLANK.                   -
CN                                                                      -
CN              WHEN A "MATERIAL LABEL" HAS NOT BEEN SPECIFIED          -
CN              (COLS.13-18 OF A TYPE 13 OR TYPE 14 CARD), THE          -
CN              "MATERIAL" WILL BE INTERPRETED AS AN ISOTOPE AND        -
CN              THE "VOLUME FRACTION" WILL BE INTERPRETED AS AN ATOM     -
CN              DENSITY.                                                -
CN                                                                      -
CN              WHEN AN ISOTOPE (OR MATERIAL) IS REFERENCED MORE THAN   -
CN              ONCE FOR A SINGLE COMPOSITION, THE ATOM DENSITIES       -
CN              (OR VOLUME FRACTIONS) ARE SUMMED.                       -
CN                                                                      -
CN              TWO TYPES OF COMPOSITIONS (PRIMARY AND SECONDARY) CAN   -
CN              BE DEFINED ON TYPE 14 CARDS. SECONDARY COMPOSITIONS     -
CN              ARE MIXTURES OF MATERIALS AND/OR ISOTOPES. PRIMARY      -
CN              COMPOSITIONS ARE MIXTURES OF SECONDARY COMPOSITIONS,    -
CN              MATERIALS AND/OR ISOTOPES. ONLY PRIMARY COMPOSITIONS    -
CN              MAY BE ASSIGNED TO REGIONS ON THE TYPE 15 CARDS.        -
CN                                                                      -
CN              SECONDARY COMPOSITIONS ARE TREATED AS CCCC SUBZONES.    -
CN              THOSE CONSTITUENTS OF A PRIMARY COMPOSITION WHICH ARE   -
CN              NOT THEMSELVES SUBZONES (I.E. ISOTOPES AND MATERIALS    -
CN              DIRECTLY ASSIGNED TO PRIMARY COMPOSITIONS) ARE          -
CN              COMBINED INTO CCCC PRIMARY ZONE ASSIGNMENTS.            -
CN                                                                      -
CN              AN EXAMPLE OF A SET OF TYPE 13 AND 14 CARDS             -
CN                                                                      -
CN              13  FUEL1 U238    .020    PU239 .003    O16    .042     -
CN              13  FUEL2 U238    .015    PU239 .004    O16    .042     -
CN              13  SS    FE      .055    CR    .015    NI     .012     -
CN              13  COOL  NA23    .022    SS    0.1                     -
CN              14  MIX1  FUEL1   1.0                                   -
CN              14  MIX2  FUEL1   0.5     FUEL2 0.5                     -
CN              14  COMP1 MIX1    0.4     SS    0.2     COOL   0.4      -
CN              14  COMP2 MIX2    0.4     SS    0.2     COOL   0.4      -
CN              14  COMP3 MIX1    0.2     MIX2  0.2     SS     0.2      -
CN              14  COMP3 COOL    0.2                                   -
CN              14  COMP4 NA23    .022                                  -
CN                                                                      -
CN              THE MATERIAL COOL IS DEFINED IN TERMS OF AN            -
CN              ISOTOPE (NA23) AND A MATERIAL (SS).                     -
CN                                                                      -
CN              MIX1 AND MIX2 ARE SECONDARY COMPOSITIONS.              -
CN              COMP1, COMP2, COMP3 AND COMP4 ARE PRIMARY              -
CN              COMPOSITIONS.                                          -
```

```
CN                                                                       -
CN                    IN THE CCCC FILES MIX1 WILL BE ASSIGNED AS         -
CN                    SUBZONES TO BOTH COMP1 AND COMP3. THE PRIMARY       -
CN                    ZONE ASSIGNMENTS OF COMP1, COMP2 AND COMP3          -
CN                    WILL CONSIST OF SS AND COOL. COMP4 WILL HAVE        -
CN                    NO SUBZONES.                                        -
C                                                                        -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR           ASSIGNMENT OF REGION TO COMPOSITION (CCCC ZONE)             -
CR           (TYPE 15)                                                   -
C                                                                        -
CL     FORMAT-----(I2,4X,11A6)                                          -
C                                                                        -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY                -
CD  =  =======  =========================================================-
CD  1  1-2      15                                                       -
CD                                                                       -
CD  2  7-12     COMPOSITION (CCCC ZONE) LABEL (REPEATED ON ADDITIONAL    -
CD              TYPE 15 CARDS).                                          -
CD                                                                       -
CD  3  13-18    REGION LABEL OR AREA LABEL DEFINING REGION(S)            -
CD              CONTAINING SPECIFIED COMPOSITION.                        -
CD                                                                       -
CD  4  19-24    REGION LABEL OR AREA LABEL DEFINING REGION(S)            -
CD              CONTAINING SPECIFIED COMPOSITION.                        -
CD                                                                       -
CD  5  25-30    REGION LABEL OR AREA LABEL DEFINING REGION(S)            -
CD              CONTAINING SPECIFIED COMPOSITION.                        -
CD                                                                       -
CD  6  31-36    REGION LABEL OR AREA LABEL DEFINING REGION(S)            -
CD              CONTAINING SPECIFIED COMPOSITION.                        -
CD                                                                       -
CD  7  37-42    REGION LABEL OR AREA LABEL DEFINING REGION(S)            -
CD              CONTAINING SPECIFIED COMPOSITION.                        -
CD                                                                       -
CD  8  43-48    REGION LABEL OR AREA LABEL DEFINING REGION(S)            -
CD              CONTAINING SPECIFIED COMPOSITION.                        -
CD                                                                       -
CD  9  49-54    REGION LABEL OR AREA LABEL DEFINING REGION(S)            -
CD              CONTAINING SPECIFIED COMPOSITION.                        -
CD                                                                       -
CD 10  55-60    REGION LABEL OR AREA LABEL DEFINING REGION(S)            -
CD              CONTAINING SPECIFIED COMPOSITION.                        -
CD                                                                       -
CD 11  61-66    REGION LABEL OR AREA LABEL DEFINING REGION(S)            -
CD              CONTAINING SPECIFIED COMPOSITION.                        -
CD                                                                       -
CD 12  67-72    REGION LABEL OR AREA LABEL DEFINING REGION(S)            -
CD              CONTAINING SPECIFIED COMPOSITION.                        -
C                                                                        -
CN              AN AREA LABEL IN COLS. 13-72 IMPLIES ALL THE REGIONS     -
CN              ASSIGNED TO THAT AREA.  AREAS ARE DEFINED ON THE         -
CN              TYPE 07 CARD.                                            -
CN                                                                       -
CN              WHEN A PARTICULAR REGION OR AREA IS REFERENCED ON        -
CN              MORE THAN ONE TYPE 15 CARD, THE LAST REFERENCE           -
CN              TO THAT REGION (EITHER DIRECTLY, OR THROUGH AN AREA)      -
CN              ESTABLISHES THE COMPOSITION ASSIGNMENT.                  -
CN              I.E. A REGION/COMPOSITION CORRESPONDENSE ESTABLISHED     -
CN              ON ONE TYPE 15 CARD CAN BE OVERWRITTEN BY A              -
CN              REFERENCE ON A LATER TYPE 15 CARD.                       -
CN                                                                       -
CN              COMPOSITION LABELS MUST BE NON-BLANK.  THE FIRST         -
CN              BLANK REGION LABEL ENCOUNTERED TERMINATES READING        -
CN              OF THE DATA ON THAT PARTICULAR TYPE 15 CARD.             -
CN                                                                       -
CN              ONLY PRIMARY COMPOSITION LABELS (SEE CARD TYPE 14)       -
CN              CAN APPEAR IN COLS. 7-12. PRIMARY COMPOSITIONS ARE       -
CN              EQUIVALENT TO CCCC ZONES. A REGION CAN CONTAIN ONLY      -
```

```
CN                  ONE PRIMARY COMPOSITION.                              -
CN                                                                       -
CN                  WHEN THERE ARE NO TYPE 14 CARDS (THE MACROSCOPIC     -
CN                  CROSS SECTIONS ALREADY EXIST) THE COMPOSITION        -
CN                  LABEL FIELDS SHOULD CONTAIN COMPOSITION NUMBERS      -
CN                  INSTEAD (I2,4X,I6,10A6).                             -
C                                                                        -
C------------------------------------------------------------------------


C------------------------------------------------------------------------
CR            DISTRIBUTED ISOTROPIC INHOMOGENEOUS SOURCE DATA DEFINED    -
CR            EITHER BY REGION OR MESH INTERVAL (TYPE 19)                -
C                                                                        -
CL    FORMAT-----(I2,4X,A6,2I6,4E12.5)                                   -
C                                                                        -
C                                                                        -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY                 -
CD  =  =======  ========================================================-
CD  1  1-2      19                                                       -
CD                                                                       -
CD  2  7-12     LABEL OF REGION OR AREA (BLANK IF DATA ARE GIVEN BY      -
CD              MESH INTERVALS).  IF THE GEOMETRY HAS BEEN SPECIFIED     -
CD              BY AN INPUT GEODST FILE (AND NOT BY A.NIP TYPE 06        -
CD              OR 30 CARDS) USE THE REGION NUMBER (I6) INSTEAD OF       -
CD              THE REGION LABEL.                                        -
CD                                                                       -
CD  3  13-18    HIGHER-ENERGY GROUP NUMBER.                              -
CD                                                                       -
CD  4  19-24    LOWER-ENERGY GROUP NUMBER.                               -
CD                                                                       -
CD  5  25-36    ISOTROPIC SOURCE VALUE IN THE SPECIFIED MESH INTERVAL,   -
CD              REGION OR AREA FOR THIS ENERGY RANGE.  (NEUTRONS PER     -
CD              SECOND PER UNIT VOLUME).                                 -
CD                                                                       -
CD  6  37-48    LOWER "X" DIRECTION COORDINATE OF MESH INTERVAL          -
CD              CONTAINING THIS SOURCE.                                  -
CD                                                                       -
CD  7  49-60    LOWER "Y" DIRECTION COORDINATE OF MESH INTERVAL          -
CD              CONTAINING THIS SOURCE.                                  -
C                                                                        -
CD  8  61-72    LOWER Z DIRECTION COORDINATE OF MESH INTERVAL            -
CD              CONTAINING THIS SOURCE.                                  -
CD                                                                       -
CN              AN AREA LABEL IN COLS. 7-12 IMPLIES ALL THE REGIONS      -
CN              ASSIGNED TO THAT AREA.                                   -
CN                                                                       -
CN              IF THERE IS NO REGION LABEL (COLS. 7-12 ARE BLANK),      -
CN              THE SOURCE SPECIFIED IN COLS. 25-36 IS PLACED IN THE     -
CN              MESH BOX DEFINED BY COLS. 37-48, 49-60 AND 61-72.        -
CN                                                                       -
CN              IF THERE IS A REGION LABEL (COLS. 7-12 ARE NON-BLANK),   -
CN              THE MESH COORDINATE FIELDS (COLS. 37-48, 49-60 AND       -
CN              61-72) ARE IGNORED AND THE SOURCE SPECIFIED IN COLS.     -
CN              25-36 IS PLACED IN EVERY MESH BOX IN THE REGION.         -
CN                                                                       -
CN              "X" REPRESENTS THE FIRST DIMENSION COORDINATE (X IN      -
CN              X-Y GEOMETRY, R IN R-Z, ETC.). "Y" REPRESENTS THE        -
CN              SECOND DIMENSION COORDINATE (Y IN X-Y GEOMETRY, Z IN     -
CN              R-Z, ETC.). WHEN THE MODEL IS THREE-DIMENSIONAL, THE     -
CN              THIRD DIMENSION IS ALWAYS Z.                             -
C                                                                        -
CN              IN GEOMETRIES INVOLVING AN ANGULAR DIMENSION (THETA)     -
CN              THE ANGULAR VARIABLE MUST BE GIVEN IN RADIANS.           -
CN                                                                       -
CN              IF NO "HIGHER-ENERGY GROUP NUMBER" IS SUPPLIED (COLS.    -
CN              13-18 ARE BLANK), THE SOURCE VALUE GIVEN APPLIES TO      -
CN              ALL ENERGY GROUPS. IF NO "LOWER-ENERGY GROUP NUMBER"     -
CN              IS SUPPLIED (COLS. 19-24 ARE BLANK), THE SOURCE VALUE    -
CN              GIVEN APPLIES TO THE "HIGHER-ENERGY GROUP" ONLY. IF      -
CN              NO GROUP NUMBERS ARE SUPPLIED (COLS. 13-24 ARE BLANK),   -
CN              THE SOURCE VALUE GIVEN APPLIES TO ALL ENERGY GROUPS.     -
```

```
CN                                                               -
CN            DATA ON THIS CARD MAY BE OVERLAYED. THAT IS, SOURCE  -
CN            VALUES DEFINED ON LATER TYPE 19 CARDS SUPERSEDE DATA -
CN            FOR REGIONS AND GROUPS PREVIOUSLY SPECIFIED.        -
CN                                                               -
CN            AN EDIT OF THE OUTPUT FIXSRC FILE MAY BE OBTAINED BY -
CN            SUPPLYING THE EDIT SENTINEL ON THE TYPE 40 CARD.    -
C                                                                -
C------------------------------------------------------------------


C------------------------------------------------------------------
CR          SEARCH EDIT OPTIONS AND CONVERGENCE CRITERIA (TYPE 21)   -
C                                                                -
CL    FORMAT-----(I2,10X,2I6,2E12.5,2I6)                         -
C                                                                -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY          -
CD  =  =======  =========================================================-
CD  1  1-2      21                                               -
CD                                                               -
CD  2  13-18    SEARCH FILE PROCESSING EDIT SENTINEL             -
CD                   0, NO EDITS (DEFAULT).                       -
CD                   1, PRINT EDITS.                              -
CD                   2, WRITE EDITS TO AUXILIARY OUTPUT FILE.     -
CD                   3, WRITE EDITS TO BOTH PRINT AND AUXILIARY OUTPUT -
CD                      FILE.                                     -
CD                                                               -
CD  3  19-24    MAXIMUM NUMBER OF SEARCH PASSES (DEFAULT=4).      -
CD                                                               -
CD  4  25-36    DESIRED KEFF, KEFF(0) (DEFAULT=1.0).              -
CD                                                               -
CD  5  37-48    CONVERGENCE CRITERION, EPSILON: RELATIVE ERROR BOUND -
CD             FOR KEFF (DEFAULT=.01).                           -
CD                                                               -
CD             ABSOLUTE VALUE OF ((KEFF-KEFF(0)) / KEFF(0)).LE.  -
CD             EPSILON.                                          -
CD                                                               -
CD  6  49-54    SEARCH (MODULE) PARAMETER EDIT OPTIONS           -
CD             ENTER TWO-DIGIT NUMBER (IF) WHERE                 -
CD                                                               -
CD             I CONTROLS INTERMEDIATE PASS PARAMETER EDITS      -
CD             F CONTROLS FINAL SEARCH PASS PARAMETER EDITS      -
CD                                                               -
CD             THE INTEGERS I AND F ARE ASSIGNED ONE OF THE      -
CD             FOLLOWING VALUES (LEADING ZEROES ARE IRRELEVANT)  -
CD             0...NO EDITS                                      -
CD             1...PRINT EDITS (DEFAULT FOR F)                   -
CD             2...WRITE EDITS TO AUXILIARY OUTPUT FILE          -
CD             3...WRITE EDITS TO BOTH PRINT AND AUXILIARY OUTPUT FILE-
CD                                                               -
CD  7  55-60    SEARCH (MODULE) QUANTITY EDIT OPTIONS            --
CD             ENTER TWO-DIGIT NUMBER (IF) WHERE                 -
CD                                                               -
CD             I CONTROLS INTERMEDIATE PASS QUANTITY EDITS       -
CD             F CONTROLS FINAL SEARCH PASS QUANTITY EDITS       -
CD                                                               -
CD             THE INTEGERS I AND F ARE ASSIGNED ONE OF THE      -
CD             FOLLOWING VALUES (LEADING ZEROES ARE IRRELEVANT)  -
CD             0...NO EDITS (DEFAULT)                            -
CD             1...PRINT EDITS                                   -
CD             2...WRITE EDITS TO AUXILIARY OUTPUT FILE          -
CD             3...WRITE EDITS TO BOTH PRINT AND AUXILIARY OUTPUT FILE-
C                                                                -
CN            EACH SEARCH PASS REQUIRES THE SUCCESSFUL COMPLETION  -
CN            OF AN EIGENVALUE PROBLEM BY A NEUTRONICS MODULE.    -
CN            SUCCESSFUL NEUTRONICS MODULE COMPLETION IS INDICATED BY-
CN               1.  OUTER ITERATIONS CONVERGED OR              -
CN               2.  MAXIMUM NUMBER OF OUTER ITERATIONS ATTAINED.  -
C                                                                -
CN            NONZERO DATA ON THIS CARD OVERRIDES DATA IN AN EXISTING-
CN            SEARCH FILE DURING A SEARCH PROBLEM RESTART.       -
C                                                                -
```

95

```
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR            SEARCH PARAMETER DATA (TYPE 22)                          -
C                                                                      -
CL     FORMAT-----(I2,10X,5E12.5)                                      -
C                                                                      -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY               -
CD  =  =======  ========================================================-
CD  1  1-2      22                                                     -
CD                                                                     -
CD  2  13-24    INITIAL ESTIMATE OF X (DEFAULT=0.0).                   -
CD                                                                     -
CD  3  25-36    SECOND ESTIMATE OF X (IGNORED IF COLS. 61-72 ARE       -
CD              NON-ZERO) (DEFAULT=0.1 (X=0.0), =1.1*X (X NE 0.0))     -
CD                                                                     -
CD  4  37-48    LOWER BOUND FOR X (DEFAULT=0.0).                       -
CD                                                                     -
CD  5  49-60    UPPER BOUND FOR X (DEFAULT=1.0).                       -
CD                                                                     -
CD  6  61-72    DERIVATIVE OF KEFF WITH RESPECT TO X (OPTIONAL).       -
CN              (PROVIDES AN ALTERNATE METHOD FOR OBTAINING SECOND     -
CN              ESTIMATE OF X IN COLS. 25-36).                         -
C                                                                      -
CN              COLS. 25-36 ARE IGNORED IF COLS. 61-72 CONTAIN OTHER   -
CN              THAN BLANK OR 0.0.                                     -
CN                                                                     -
CN              GENERAL SEARCH EXPRESSION:  P(X) = P(0) + X * M,       -
CN              WHERE P IS THE QUANTITY BEING VARIED, X IS THE SEARCH  -
CN              PARAMETER, AND M IS THE QUANTITY MODIFIER OBTAINED     -
CN              FROM INFORMATION CONTAINED ON ONE OF THE MUTUALLY      -
CN              EXCLUSIVE CARD TYPES 23, 24, 25, OR 26.  X IS TO BE    -
CN              VARIED UNTIL THE DESIRED KEFF IS REACHED.  THE SEARCH  -
CN              WILL BE TERMINATED IF X EXCEEDS ITS BOUNDS OR IF THE   -
CN              MAXIMUM NUMBER OF SEARCH PASSES ARE REACHED.           -
CN              (SOME CODES MAY ALSO TRIGGER JOB TERMINATION BETWEEN   -
CN              SEARCH PASSES IF IT IS ESTIMATED THAT JOB TIME LIMIT   -
CN              WOULD BE EXCEEDED DURING THE NEXT SEARCH PASS).        -
CN                                                                     -
CN              FOR EFFICIENT SEARCHING, SCALE THE SEARCH QUANTITY     -
CN              SUCH THAT THE MAGNITUDES OF THE SEARCH PARAMETER       -
CN              ESTIMATES LIE IN THE INTERVAL (.1,10.)                 -
CN                                                                     -
CN              NONZERO DATA ON THIS CARD OVERRIDES DATA IN AN EXISTING-
CN              SEARCH FILE DURING A SEARCH PROBLEM RESTART.           -
C                                                                      -
C-----------------------------------------------------------------------


C-----------------------------------------------------------------------
CR            CONCENTRATION MODIFIERS FOR CRITICALITY SEARCH (TYPE 23)  -
C                                                                      -
CL     FORMAT-----(I2,4X,11A6)                                         -
C                                                                      -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY               -
CD  =  =======  ========================================================-
CD  1  1-2      23                                                     -
CD                                                                     -
CD  2  7-12     COMPOSITION LABEL OF COMPOSITION (FROM CARD TYPE 14)   -
CD              TO BE USED AS THE MODIFIER M IN THE SEARCH FORMULA.    -
CD                                                                     -
CD  3  13-18    COMPOSITION LABEL OF COMPOSITION (FROM CARD TYPE 14)   -
CD              TO WHICH MODIFIER M IS ADDED AS A SUBZONE.             -
CD                                                                     -
CD  4  19-24    COMPOSITION LABEL OF COMPOSITION (FROM CARD TYPE 14)   -
CD              TO WHICH MODIFIER M IS ADDED AS A SUBZONE.             -
CD                                                                     -
CD  5  25-30    COMPOSITION LABEL OF COMPOSITION (FROM CARD TYPE 14)   -
CD              TO WHICH MODIFIER M IS ADDED AS A SUBZONE.             -
CD                                                                     -
CD  6  31-36    COMPOSITION LABEL OF COMPOSITION (FROM CARD TYPE 14)   -
```

```
CD                TO WHICH MODIFIER M IS ADDED AS A SUBZONE.       -
CD                                                                 -
CD  7  37-42      COMPOSITION LABEL OF COMPOSITION (FROM CARD TYPE 14)  -
CD                TO WHICH MODIFIER M IS ADDED AS A SUBZONE.       -
CD                                                                 -
CD  8  43-48      COMPOSITION LABEL OF COMPOSITION (FROM CARD TYPE 14)  -
CD                TO WHICH MODIFIER M IS ADDED AS A SUBZONE.       -
CD                                                                 -
CD  9  49-54      COMPOSITION LABEL OF COMPOSITION (FROM CARD TYPE 14)  -
CD                TO WHICH MODIFIER M IS ADDED AS A SUBZONE.       -
CD                                                                 -
CD 10  55-60      COMPOSITION LABEL OF COMPOSITION (FROM CARD TYPE 14)  -
CD                TO WHICH MODIFIER M IS ADDED AS A SUBZONE.       -
CD                                                                 -
CD 11  61-66      COMPOSITION LABEL OF COMPOSITION (FROM CARD TYPE 14)  -
CD                TO WHICH MODIFIER M IS ADDED AS A SUBZONE.       -
CD                                                                 -
CD 12  67-72      COMPOSITION LABEL OF COMPOSITION (FROM CARD TYPE 14)  -
CD                TO WHICH MODIFIER M IS ADDED AS A SUBZONE.       -
C                                                                  -
CN                IN THE SEARCH FORMULA  P(X) = P(0) + X * M,      -
CN                P(0) DENOTES THOSE PRIMARY COMPOSITIONS (ZONES,  -
CN                COLS. 13-72) TO WHICH THE MODIFIER COMPOSITIONS (M,  -
CN                COLS. 7-12) ARE ADDED AS SUBZONES,               -
CN                X IS THE VOLUME FRACTION APPLIED TO THE MODIFIER -
CN                COMPOSITIONS (CCCC ZONES OR SUBZONES) COMPRISING M,  -
CN                AND P(X) DENOTES THE RESULTANT COMPOSITIONS.     -
CN                CARD TYPE 23 DEFINES P(0) AND M IN TERMS OF COMPOSITION-
CN                LABELS DEFINED ON CARD TYPE 14.                  -
CN                                                                 -
CN                THE MODIFIER COMPOSITION (CCCC ZONE OR SUBZONE) NAME  -
CN                IN COLS. 7-12 MUST BE A SUBZONE OR AN UNASSIGNED (NOT -
CN                ASSIGNED TO A REGION ON A TYPE 15 CARD) PRIMARY ZONE  -
CN                CONTAINING NO SUBZONES.                          -
CN                                                                 -
CN                THE MODIFIER COMPOSITIONS (M) BECOME SUBZONES OF -
CN                EACH ZONE SPECIFIED IN COLS. 13-72.  WHEN A SUBZONE IS -
CN                SPECIFIED IN COLS 13-72, THE MODIFIER COMPOSITIONS (M) -
CN                BECOME SUBZONES IN EACH ZONE CONTAINING THE SUBZONE  -
CN                IN COLS. 13-72.  IN BOTH CASES THE VOLUME FRACTION  -
CN                OF THE ADDED SUBZONES IS X.                      -
CN                                                                 -
CN                A MODIFIER COMPOSITION (M) CANNOT MODIFY ANOTHER -
CN                MODIFIER COMPOSITION OR A COMPOSITION WHICH ALREADY  -
CN                CONTAINS THE MODIFIER COMPOSITION AS A ZONE OR SUBZONE.-
CN                                                                 -
CN                AN EXAMPLE OF A SET OF TYPE 23 CARDS USING THE SAMPLE  -
CN                TYPE 14 CARDS PRESENTED IN THE TYPE 14 CARD DESCRIPTION-
CN                FOLLOWS:                                         -
CN                                                                 -
CN                   23  COMP4 COMP1 MIX2                          -
CN                   23  MIX1  COMP2                               -
CN                                                                 -
CN                     IN THE CCCC FILES COMP4 WILL BECOME A SUBZONE  -
CN                     OF COMP1, COMP2 AND COMP3.  MIX1 WILL BECOME -
CN                     A SUBZONE OF COMP2.                         -
CN                                                                 -
CN                REPEAT TYPE 23 CARDS AS NEEDED.                  -
C                                                                  -
C------------------------------------------------------------------
 

C------------------------------------------------------------------
CR          MESH MODIFIERS FOR CRITICALITY SEARCH (TYPE 24)       -
C                                                                  -
CL    FORMAT-----(I2,9X,A1,3E12.5)                                 -
C                                                                  -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY          -
CD  =  =======  ========================================================-
CD  1  1-2      24                                                 -
CD                                                                 -
CD  2  12       COORDINATE DIRECTION.                              -
```

```
CD                    X..."X" COORDINATE DIRECTION.                    -
CD                    Y..."Y" COORDINATE DIRECTION.                    -
CD                    Z..."Z" COORDINATE DIRECTION.                    -
CD                                                                     -
CD   3   13-24    LOWER (COARSE MESH) COORDINATE.                      -
CD                                                                     -
CD   4   25-36    UPPER (COARSE MESH) COORDINATE.                      -
CD                                                                     -
CD   5   37-48    MESH MODIFIER, M, FOR EACH MESH INTERVAL BETWEEN     -
CD                THE ABOVE COORDINATES.                               -
C                                                                      -
CN                    IN THE SEARCH FORMULA P(X) = P(0) + X * M,       -
CN                    P(X) IS THE RESULTING MESH INTERVAL,             -
CN                    P(0) IS THE INITIAL MESH INTERVAL, AND           -
CN                    M IS THE MESH INTERVAL MODIFIER.                 -
CN                                                                     -
CN                    DATA ON THIS CARD MAY BE OVERLAYED.  THAT IS MESH -
CN                    MODIFIERS DEFINED ON LATER TYPE 24 CARDS SUPERSEDE -
CN                    DATA FOR REGIONS SPECIFIED PREVIOUSLY.           -
CN                                                                     -
CN                    REPEAT TYPE 24 CARDS AS NEEDED.                  -
C                                                                      -
C----------------------------------------------------------------------


C----------------------------------------------------------------------
CR           COMPOSITION DEPENDENT BUCKLING MODIFIERS FOR CRITICALITY  -
CR           SEARCH (TYPE 25)                                          -
C                                                                      -
CL    FORMAT-----(I2,4X,A6,2E12.5)                                     -
C                                                                      -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY              -
CD  =  =======  =========================================================-
CD  1  1-2      25                                                     -
CD                                                                     -
CD  2  7-12     COMPOSITION (ZONE) LABEL.                              -
CD                                                                     -
CD  3  13-24    BUCKLING MODIFIER, M, IN FIRST TRANSVERSE DIRECTION.   -
C                                                                      -
CD  4  25-36    BUCKLING MODIFIER, M, IN SECOND TRANSVERSE DIRECTION   -
CD                FOR A FINITE ONE-DIMENSIONAL RECTANGULAR SLAB.       -
C                                                                      -
CN                    IN THE SEARCH FORMULA   P(X) = P(0) + X * M,     -
CN                    P(X) IS THE RESULTING BUCKLING, P(0) IS THE INITIAL -
CN                    BUCKLING, AND M IS THE BUCKLING MODIFIER.        -
CN                    P(0) WILL BE EVALUATED FROM THE TRANSVERSE HEIGHTS -
CN                    GIVEN ON CARD TYPE 12 OR TAKEN DIRECTLY FROM BUCKLINGS -
CN                    GIVEN ON CARD TYPE 34.                           -
CN                                                                     -
CN                    IF COLS. 7-12 ARE BLANK, THE DATA IN COLS. 13-24 APPLY -
CN                    TO ALL COMPOSITIONS (ZONES) OF THE REACTOR.      -
CN                                                                     -
CN                    REPEAT TYPE 25 CARDS AS NEEDED.                  -
C                                                                      -
C----------------------------------------------------------------------


C----------------------------------------------------------------------
CR           ALPHA MODIFIER FOR CRITICALITY SEARCH (TYPE 26)           -
C                                                                      -
CL    FORMAT-----(I2,10X,E12.5)                                        -
C                                                                      -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY              -
CD  =  =======  =========================================================-
CD  1  1-2      26                                                     -
CD                                                                     -
CD  2  13-24    ALPHA MODIFIER, M.                                     -
CD                                                                     -
C                                                                      -
CN                    IN THE SEARCH FORMULA   P(X) = P(0) + X * M,     -
CN                    P(X) IS THE RESULTING ALPHA, P(0) IS THE INITIAL ALPHA,-
CN                    AND M IS THE ALPHA MODIFIER.                     -
```

98

```
C                                                                          -
C--------------------------------------------------------------------------


C--------------------------------------------------------------------------
CR             HEXAGON DIMENSION (TYPE 29)                                  -
C                                                                          -
CL     FORMAT-----(I2,10X,E12.5,2I6)                                        -
C                                                                          -
CD  #   COLUMNS           CONTENTS...IMPLICATIONS, IF ANY                   -
CD  =   =======   =========================================================-
CD  1   1-2       29                                                        -
CD                                                                          -
CD  2   13-24     DIMENSION OF HEXAGON ACROSS FLATS.                        -
CD                                                                          -
CD  3   25-30     TOTAL NUMBER OF HEXAGONAL RINGS IN THE REGION OF          -
CD                SOLUTION.                                                  -
CD                                                                          -
CD  4   31-36     FOR TRIANGULAR AND TRIANGULAR-Z GEOMETRIES, THE           -
CD                NUMBER OF EQUAL PARTS INTO WHICH EACH SIDE OF THE          -
CD                BASIC EQUILATERAL TRIANGLES MAKING UP THE HEXAGONS ARE     -
CD                SUBDIVIDED.  THUS E.G., IF COLS 31-36 CONTAIN 3, THE       -
CD                HEXAGON CONTAINS 54 MESH POINTS INSTEAD OF THE NORMAL      -
CD                6.                                                         -
C                                                                          -
CN                IF THE NUMBER OF RINGS IS NOT PROVIDED IN COLS. 25-30,     -
CN                IT IS DERIVED FROM THE TYPE 30 CARDS.                      -
CN                                                                          -
CN                IF COLS. 31-36 ARE BLANK, THE TRIANGLES ARE NOT           -
CN                SUBDIVIDED.                                                -
CN                                                                          -
CN                THE TYPE 29 CARD IS PERTINENT ONLY IF COLS. 13-18 ON      -
CN                CARD TYPE 03 ARE GREATER THAN OR EQUAL TO 70.             -
CN                                                                          -
CN                FOR TRIANGULAR-Z AND HEXAGONAL-Z GEOMETRIES THE           -
CN                AXIAL (Z) MESH MUST BE SPECIFIED ON TYPE 9 CARDS.          -
C                                                                          -
C--------------------------------------------------------------------------


C--------------------------------------------------------------------------
CR             LOCATIONS OF REGIONS FOR TRIANGULAR, TRIANGULAR-Z,           -
CR             HEXAGONAL, AND HEXAGONAL-Z GEOMETRIES (TYPE 30)              -
C                                                                          -
CL     FORMAT-----(I2,4X,A6,3I6,2E12.5)                                     -
C                                                                          -
CD  #   COLUMNS           CONTENTS...IMPLICATIONS, IF ANY                   -
CD  =   =======   =========================================================-
CD  1   1-2       30                                                        -
CD                                                                          -
CD  2   7-12      REGION LABEL (REPEATED ON ADDITIONAL TYPE 30 CARDS).      -
CD                                                                          -
CD  3   13-18     HEXAGONAL RING NUMBER WHERE REGION IS LOCATED.            -
CD                                                                          -
CD  4   19-24     STARTING HEXAGON POSITION FOR THIS REGION.               -
CD                                                                          -
CD  5   25-30     FINAL HEXAGON POSITION FOR THIS REGION.                  -
CD                                                                          -
CD  6   31-42     LOWER Z BOUNDARY OF REGION.                              -
CD                                                                          -
CD  7   43-54     UPPER Z BOUNDARY OF REGION.                              -
CD                                                                          -
C                                                                          -
CN                REGION LABELS MUST BE NON-BLANK.                          -
CN                                                                          -
CN                IF THE STARTING POSITION (COLS. 19-24) IS BLANK OR        -
CN                ZERO, THE REGION LABEL IS ASSIGNED TO THE WHOLE RING.     -
CN                                                                          -
CN                IF THE FINAL POSITION (COLS. 25-30) IS BLANK OR ZERO,     -
CN                THE REGION LABEL IS ASSIGNED TO THE POSITION IN 19-24     -
CN                OF THE RING IN 13-18.                                     -
CN                                                                          -
```

```
CN              DATA ON THIS CARD MAY BE OVERLAYED. THAT IS, REGION    -
CN              ASSIGNMENTS DEFINED ON LATER TYPE 30 CARDS SUPERSEDE   -
CN              DATA FOR RINGS AND POSITIONS PREVIOUSLY SPECIFIED.     -
CN                                                                     -
CN              THE REGION LOWER AND UPPER Z BOUNDARIES MUST COINCIDE  -
CN              WITH MESH LINES, WHICH BOUND MESH INTERVALS.           -
CN                                                                     -
CN              THE FIGURE BELOW ILLUSTRATES THE ORDER OF NAMING       -
CN              RINGS AND HEXAGONS IN THE RINGS.  THE FIRST NUMBER OF  -
CN              EACH NUMBERED PAIR IS THE RING NUMBER, AND THE SECOND  -
CN              NUMBER IS THE HEXAGON NUMBER IN THAT RING.             -
CN              THE REGION OF SOLUTION DEPENDS ON THE VALUE IN COLS.   -
CN              13-18 ON CARD TYPE 03 AS FOLLOWS.                      -
CN                                                                     -
CN         COLS. 13-18 ON CARD TYPE 03        REGION OF SOLUTION       -
CN         ===========================    ============================ -
CN                   80                    ENTIRE FIGURE AS SHOWN BELOW -
CN                   72                    IN THE 180 DEGREE SECTOR A-B -
CN                   78                    IN THE 90 DEGREE SECTOR A-C  -
CN                   70                    IN THE 60 DEGREE SECTOR A-D  -
CN                   74                    IN THE 120 DEGREE SECTOR A-E -
CN                   110                   ENTIRE FIGURE AS SHOWN BELOW -
CN                   114                   IN THE 60 DEGREE SECTOR F-C  -
CN                   116                   IN THE 120 DEGREE SECTOR F-G -
CN                                                                     -
CN                        G                E                C          -
CN                                                                     -
CN                    *               *               *                -
CN                                                                     -
CN          B                 *               *               *        -
CN            *                                                     D  -
CN              *         *               *               *        *   -
CN                *           ====== ====== ======            *        -
CN                  *         =3,5 = =3,4 = =3,3 =        *             -
CN                    *       ====== ====== ======    *                -
CN                     ====== ====== ====== ======                     -
CN                     =3,6 = =2,3 = =2,2 = =3,2 =                      -
CN                     ====== ====== ====== ======                     -
CN              ====== ====== ====== ====== ======                     -
CN              =3,7 = =2,4 = =1,1 = =2,1 = =3,1 =  *  *  *  F          -
CN              ====== ====== ====== ====== ======                     -
CN                     ====== ====== ====== ======                     -
CN                     =3,8 = =2,5 = =2,6 = =3,12=                      -
CN                     ====== ====== ====== ======                     -
CN                        ====== ====== ======         *               -
CN                        =3,9 = =3,10= =3,11=      *                   -
CN                        ====== ====== ======    *                    -
CN                                               *                     -
CN                                                  A                  -
CN                                                                     -
CN                                                                     -
CN              ALTHOUGH THE REGIONS OF SOLUTION DIFFER FOR THE        -
CN              TRIANGULAR AND HEXAGONAL GEOMETRY MODELS, TYPE 30      -
CN              CARDS COMPOSED FOR TRIANGULAR GEOMETRY MODELS CAN ALSO -
CN              BE USED FOR HEXAGONAL GEOMETRY MODELS.                 -
CN                                                                     -
C                                                                      -
C----------------------------------------------------------------------


C----------------------------------------------------------------------
CR            BACKGROUND REGION NAME FOR TRIANGULAR, TRIANGULAR-Z,     -
CR            HEXAGONAL, AND HEXAGONAL-Z GEOMETRIES (TYPE 31)          -
C                                                                      -
CL      FORMAT-----(I2,4X,A6)                                          -
C                                                                      -
CD  #   COLUMNS           CONTENTS...IMPLICATIONS, IF ANY              -
CD  =   =======   ======================================================-
CD  1   1-2       31                                                   -
CD                                                                     -
CD  2   7-12      BACKGROUND REGION NAME.                              -
C                                                                      -
```

100

```
CN                     ANY PORTION OF THE REACTOR NOT SPECIFIED ON THE      -
CN                     TYPE 30 CARDS WILL BE IN THE BACKGROUND REGION.      -
CN                                                                          -
CN                     IF THE BACKGROUND REGION NAME (COLS. 7-12) IS BLANK, -
CN                     OR IF THERE IS NO TYPE 31 CARD, THE BACKGROUND REGION -
CN                     WILL BE ASSIGNED A REGION NUMBER 0 (ZERO).  NOTE THAT -
CN                     SOME CCCC CODES EXCLUDE SUCH A REGION FROM THE REGION -
CN                     OF SOLUTION, WHILE OTHER CCCC CODES MAY NOT ALLOW     -
CN                     ZERO REGION NUMBERS.                                 -
C                                                                           -
C-------------------------------------------------------------------------


C-------------------------------------------------------------------------
CR             COMPOSITION AND GROUP DEPENDENT BUCKLING SPECIFICATIONS      -
CR             (TYPE 34)                                                    -
C                                                                           -
CL     FORMAT-----(I2,4X,A6,2(E12.5,2I6))                                   -
C                                                                           -
CD  #  COLUMNS              CONTENTS...IMPLICATIONS, IF ANY                 -
CD  =  =======  ========================================================-
CD  1  1-2      34                                                          -
CD                                                                          -
CD  2  7-12     COMPOSITION LABEL.                                          -
CD                                                                          -
CD  3  13-24    BUCKLING (B**2).                                            -
CD                                                                          -
CD  4  25-30    HIGHER ENERGY BROAD GROUP NUMBER TO WHICH BUCKLING          -
CD              IN COLS. 13-24 APPLIES.                                     -
CD                                                                          -
CD  5  31-36    LOWER ENERGY BROAD GROUP NUMBER TO WHICH BUCKLING           -
CD              IN COLS. 13-24 APPLIES.                                     -
CD                                                                          -
CD  6  37-48    BUCKLING (B**2).                                            -
CD                                                                          -
CD  7  49-54    HIGHER ENERGY BROAD GROUP NUMBER TO WHICH BUCKLING          -
CD              IN COLS. 37-48 APPLIES.                                     -
CD                                                                          -
CD  8  55-60    LOWER ENERGY BROAD GROUP NUMBER TO WHICH BUCKLING           -
CD              IN COLS. 37-48 APPLIES.                                     -
C                                                                           -
CN              IF THERE IS NO COMPOSITION LABEL (COLS. 7-12 ARE            -
CN              BLANK), THE BUCKLINGS ON THIS CARD WILL APPLY TO            -
CN              ALL COMPOSITIONS.                                           -
CN                                                                          -
CN              IF NO "HIGHER-ENERGY GROUP NUMBER" IS SUPPLIED IN           -
CN              COLS. 25-30, THE BUCKLING GIVEN IN COLS. 13-24 APPLIES -
CD              TO ALL ENERGY GROUPS.  IF THERE IS A "HIGHER-ENERGY         -
CD              GROUP NUMBER" IN COLS. 25-30, BUT NO "LOWER-ENERGY          -
CD              GROUP NUMBER" IS SUPPLIED IN COLS. 31-36, THE BUCKLING -
CD              GIVEN IN COLS. 13-24 APPLIES TO THE "HIGHER-ENERGY          -
CD              GROUP" ONLY.                                                -
CN                                                                          -
CN              IF NO "HIGHER-ENERGY GROUP NUMBER" IS SUPPLIED IN           -
CN              COLS. 49-54, THE DATA IN COLS. 37-60 ARE IGNORED. IF        -
CN              THERE IS A "HIGHER-ENERGY GROUP NUMBER" IN COLS. 49-54,-
CN              BUT NO "LOWER-ENERGY GROUP NUMBER" IN COLS. 55-60,          -
CN              THE BUCKLING GIVEN IN COLS. 37-48 APPLIES TO THE            -
CN              "HIGHER-ENERGY GROUP" ONLY.                                 -
CN                                                                          -
CN              BUCKLINGS CAN BE OVERLAYED. THAT IS, BUCKLINGS DEFINED -
CN              ON LATER TYPE 34 CARDS SUPERSEDE DATA FOR COMPOSITIONS -
CN              AND/OR ENERGY RANGES PREVIOUSLY DEFINED. THE EXCEPTION -
CN              TO THIS RULE IS THE SITUATION DESCRIBED IN THE PRE-         -
CN              CEDING PARAGRAPHS WHERE DATA IS SPECIFICALLY IGNORED.       -
CN                                                                          -
CN              EXAMPLE          34     **   .001  1  3   .002  4  7        -
CN                               34     COMP1 .003  1  5                    -
CN                               34     COMP1 .004  3                       -
CN                               34     COMP2 .005                          -
CN                                                                          -
CN              THIS EXAMPLE IS IN FREE-FORMAT - ** IMPLIES A BLANK         -
```

101

```
CN                  LABEL.  COMPOSITION COMP1 IS BUCKLED .003 IN GROUPS   -
CN                  1-2, .004 IN GROUP 3, .003 IN GROUPS 4-5, .002 IN     -
CN                  GROUPS 6-7, AND ZERO IN ALL OTHER GROUPS.             -
CN                  COMPOSITION COMP2 IS BUCKLED .005 IN ALL GROUPS.  ALL -
CN                  OTHER COMPOSITIONS ARE BUCKLED .001 IN GROUPS 1-3,    -
CN                  .002 IN GROUPS 4-7 AND ZERO IN ALL OTHER GROUPS.      -
CN                                                                        -
CN                  WHEN ANY TYPE 34 CARDS EXIST, BUCKLINGS WILL NOT BE   -
CN                  CALCULATED FROM FINITE GEOMETRY DATA ON TYPE 12 CARDS.-
C                                                                         -
C-------------------------------------------------------------------------


C-------------------------------------------------------------------------
CR            DIRECTIONAL DIFFUSION COEFFICIENT FACTOR SCHEME (TYPE 35)   -
C                                                                         -
CL      FORMAT-----(I2,4X,A6,6F6.2,2I6)                                   -
C                                                                         -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY                  -
CD  =  =======  ========================================================-
CD  1  1-2      35                                                        -
CD                                                                        -
CD  2  7-12     DIRECTIONAL DIFFUSION COEFFICIENT FACTOR SCHEME LABEL.    -
CD                                                                        -
CD  3  13-18    FIRST DIMENSION DIFFUSION COEFFICIENT MULTIPLIER, A1.     -
CD                                                                        -
CD  4  19-24    FIRST DIMENSION DIFFUSION COEFFICIENT ADDITIVE            -
CD              TERM, B1.                                                 -
CD                                                                        -
CD  5  25-30    SECOND DIMENSION DIFFUSION COEFFICIENT MULTIPLIER, A2.    -
CD                                                                        -
CD  6  31-36    SECOND DIMENSION DIFFUSION COEFFICIENT ADDITIVE           -
CD              TERM, B2.                                                 -
CD                                                                        -
CD  7  37-42    THIRD DIMENSION DIFFUSION COEFFICIENT MULTIPLIER, A3.     -
CD                                                                        -
CD  8  43-48    THIRD DIMENSION DIFFUSION COEFFICIENT ADDITIVE            -
CD              TERM, B3.                                                 -
CD                                                                        -
CD  9  49-54    HIGHER ENERGY BROAD GROUP NUMBER TO WHICH DATA IN         -
CD              COLS. 13-48 APPLY.                                        -
CD                                                                        -
CD 10  55-60    LOWER ENERGY BROAD GROUP NUMBER TO WHICH DATA IN          -
CD              COLS. 13-48 APPLY.                                        -
C                                                                         -
CN              IF MORE THAN ONE TYPE 35 CARD IS NEEDED FOR A GIVEN       -
CN              DIFFUSION COEFFICIENT FACTOR SCHEME, THE LABEL IN         -
CN              COLS. 7-12 MUST BE REPEATED ON EACH ADDITIONAL CARD.      -
CN                                                                        -
CN              FIRST, SECOND AND THIRD DIMENSIONS REFER TO THE           -
CN              DIMENSIONS IN THE ORDER THEY ARE NAMED ON CARD TYPE 3.    -
CN              E.G. FOR R-Z GEOMETRY R IS THE FIRST DIMENSION, AND       -
CN              Z IS THE SECOND.                                          -
CN                                                                        -
CN              THE FIRST DIMENSION DIFFUSION COEFFICIENT, D1, IS         -
CN              CALCULATED FROM THE HOMOGENEOUS DIFFUSION COEFFICIENT,    -
CN              D, AS FOLLOWS:                                            -
CN                                                                        -
CN                          D1 = A1*D+B1                                  -
CN                                                                        -
CN              THE OTHER TWO DIMENSIONS ARE HANDLED IN A SIMILAR WAY.    -
CN                                                                        -
CN              IF THE "HIGHER ENERGY BROAD GROUP NUMBER" IS NOT          -
CN              PROVIDED (COLS. 49-54 ARE BLANK OR ZERO), THE             -
CN              CONSTANTS SPECIFIED IN COLS. 13-48 WILL APPLY TO ALL      -
CN              BROAD GROUPS FOR THE PARTICULAR SCHEME.                   -
CN                                                                        -
CN              IF THE "LOWER ENERGY BROAD GROUP NUMBER" IS NOT           -
CN              PROVIDED (COLS. 55-60 ARE BLANK OR ZERO), THE             -
CN              CONSTANTS SPECIFIED IN COLS. 13-48 WILL APPLY TO THE      -
CN              HIGHER ENERGY BROAD GROUP NUMBER (COLS. 49-54) ONLY.      -
CN                                                                        -
```

```
CN              THE CONSTANTS DEFINING A PARTICULAR SCHEME CAN BE     -
CN              OVERLAYED. THAT IS, FACTORS DEFINED ON LATER TYPE 35  -
CN              CARDS SUPERSEDE DATA FOR ENERGY RANGES PREVIOUSLY     -
CN              DEFINED.                                              -
CN                                                                    -
CN              DIRECTIONAL DIFFUSION COEFFICIENT FACTOR SCHEMES ARE  -
CN              ASSIGNED TO COMPOSITIONS ON TYPE 36 CARDS.            -
CN                                                                    -
CN              IF NO TYPE 36 CARDS ARE SUPPLIED, AND ONLY ONE SCHEME -
CN              IS DEFINED (THE SAME LABEL APPEARS IN COLS. 7-12 OF   -
CN              ALL TYPE 35 CARDS), THE FACTORS WILL BE USED IN ALL   -
CN              COMPOSITIONS.                                         -
CN                                                                    -
CN              IF NO TYPE 36 CARDS ARE SUPPLIED AND MORE THAN ONE    -
CN              SCHEME IS DEFINED, THE FACTORS FOR THE FIRST DEFINED  -
CN              SCHEME (I.E. THAT SCHEME LABEL WHICH APPEARS ON THE   -
CN              FIRST TYPE 35 CARD) WILL BE USED IN ALL COMPOSITIONS. -
CN                                                                    -
CN              THE CALCULATION OF TRANSVERSE LEAKAGE BY THE DIF3D    -
CN              CODE WILL USE THE THIRD DIMENSION DIFFUSION           -
CN              COEFFICIENT FOR THE PSEUDO ABSORPTION,                -
CN                   D-B-SQUARED = (A3*D+B3)*B**2                     -
CN              REGARDLESS OF THE PROBLEM DIMENSIONS.  OTHER          -
CN              CODES USING THE COMPXS FILE MAY BEHAVE DIFFERENTLY -  -
CN              IT IS UP TO THE USER TO CHOOSE THE PROPER             -
CN              COEFFICIENT TO MODIFY.                                -
C                                                                     -
C---------------------------------------------------------------------


C---------------------------------------------------------------------
CR          DIRECTIONAL DIFFUSION COEFFICIENT FACTORS-COMPOSITION     -
CR          CORRESPONDENCE (TYPE 36)                                  -
C                                                                     -
CL    FORMAT-----(I2,4X,11A6)                                         -
C                                                                     -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY             -
CD  =  =======  =========================================================-
CD  1  1-2      36                                                    -
CD                                                                    -
CD  2  7-12     DIRECTIONAL DIFFUSION COEFFICIENT FACTOR SCHEME LABEL -
CD             (SEE CARD TYPE 35).                                    -
CD                                                                    -
CD  3  13-18    COMPOSITION TO WHICH DIFFUSION COEFFICIENT FACTORS ARE -
CD             ASSIGNED.                                              -
CD                                                                    -
CD  4  19-24    COMPOSITION TO WHICH DIFFUSION COEFFICIENT FACTORS ARE -
CD             ASSIGNED.                                              -
CD                                                                    -
CD  5  25-30    COMPOSITION TO WHICH DIFFUSION COEFFICIENT FACTORS ARE -
CD             ASSIGNED.                                              -
CD                                                                    -
CD  6  31-36    COMPOSITION TO WHICH DIFFUSION COEFFICIENT FACTORS ARE -
CD             ASSIGNED.                                              -
CD                                                                    -
CD  7  37-42    COMPOSITION TO WHICH DIFFUSION COEFFICIENT FACTORS ARE -
CD             ASSIGNED.                                              -
CD                                                                    -
CD  8  43-48    COMPOSITION TO WHICH DIFFUSION COEFFICIENT FACTORS ARE -
CD             ASSIGNED.                                              -
CD                                                                    -
CD  9  49-54    COMPOSITION TO WHICH DIFFUSION COEFFICIENT FACTORS ARE -
CD             ASSIGNED.                                              -
CD                                                                    -
CD  10 55-60    COMPOSITION TO WHICH DIFFUSION COEFFICIENT FACTORS ARE -
CD             ASSIGNED.                                              -
CD                                                                    -
CD  11 61-66    COMPOSITION TO WHICH DIFFUSION COEFFICIENT FACTORS ARE -
CD             ASSIGNED.                                              -
CD                                                                    -
CD  12 67-72    COMPOSITION TO WHICH DIFFUSION COEFFICIENT FACTORS ARE -
CD             ASSIGNED.                                              -
```

```
C                                                                  -
CN            IF MORE THAN ONE TYPE 36 CARD IS REQUIRED TO ASSIGN   -
CN            GIVEN DIFFUSION COEFFICIENT FACTORS TO COMPOSITIONS,  -
CN            THE LABEL IN COLS. 7-12 MUST BE REPEATED ON THE       -
CN            ADDITIONAL CARDS.                                     -
CN                                                                  -
CN            IF NO TYPE 36 CARDS ARE SUPPLIED, AND ONLY ONE        -
CN            DIRECTIONAL DIFFUSION COEFFICIENT FACTOR SCHEME IS    -
CN            DEFINED (THE SAME LABEL APPEARS IN COLS. 7-12 OF ALL  -
CN            TYPE 35 CARDS), THE FACTORS WILL BE USED IN ALL       -
CN            COMPOSITIONS.                                         -
CN                                                                  -
CN            IF NO TYPE 36 CARDS ARE SUPPLIED AND MORE THAN ONE    -
CN            SCHEME IS DEFINED, THE FACTORS FOR THE FIRST DEFINED  -
CN            SCHEME WILL BE USED IN ALL COMPOSITIONS.              -
CN                                                                  -
CN            IF NO COMPOSITIONS ARE DEFINED IN COLS. 13-72, THE    -
CN            SCHEME IDENTIFIED BY THE LABEL IN COLS. 7-12 WILL BE  -
CN            USED FOR ALL COMPOSITIONS.                            -
CN                                                                  -
CN            THE SCHEME-COMPOSITION CORRESPONDENCE DATA CAN BE     -
CN            OVERLAYED. THAT IS, DATA GIVEN ON LATER TYPE 36 CARDS -
CN            SUPERSEDES DATA PREVIOUSLY DEFINED.                   -
C                                                                  -
C------------------------------------------------------------------


C------------------------------------------------------------------
CR            FISSION ENERGY CONVERSION FACTOR DATA (TYPE 37)       -
C                                                                  -
CL     FORMAT-----(I2,10X,3(A6,E12.5))                             -
C                                                                  -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY            -
CD  =  =======  =========================================================-
CD  1  1-2      37                                                 -
CD                                                                 -
CD  2  13-18    COMPOSITION LABEL.                                 -
CD                                                                 -
CD  3  19-30    ENERGY CONVERSION FACTOR FOR THIS COMPOSITION      -
CD             (FISSIONS/WATT-SEC.).                               -
CD                                                                 -
CD  4  31-36    COMPOSITION LABEL.                                 -
CD                                                                 -
CD  5  37-48    ENERGY CONVERSION FACTOR FOR THIS COMPOSITION      -
CD             (FISSIONS/WATT-SEC.).                               -
CD                                                                 -
CD  6  49-54    COMPOSITION LABEL.                                 -
CD                                                                 -
CD  7  55-66    ENERGY CONVERSION FACTOR FOR THIS COMPOSITION      -
CD             (FISSIONS/WATT-SEC.).                               -
C                                                                  -
CN            IF TYPE 37 OR TYPE 38 CARDS ARE PROVIDED FOR A       -
CN            A PARTICULAR COMPOSITION, THE ENERGY CONVERSION       -
CN            FACTORS IN DATA SET ISOTXS WILL BE IGNORED FOR THAT   -
CN            COMPOSITION, AND THE DATA ON THE TYPE 37 AND TYPE 38  -
CN            CARDS WILL BE USED INSTEAD.                           -
CN                                                                  -
CN            IF THE FIRST LABEL (COLS. 13-18) ON A TYPE 37 CARD IS -
CN            BLANK, THE ASSOCIATED CONVERSION FACTOR WILL BE       -
CN            ENTERED FOR ALL COMPOSITIONS.                         -
CN                                                                  -
CN            IF COLS. 31-36 ARE BLANK THE DATA IN COLS. 37-66 ARE  -
CN            NEGLECTED.  IF COLS. 49-54 ARE BLANK THE DATA IN      -
CN            COLS. 55-66 ARE NEGLECTED.                            -
CN                                                                  -
CN            DATA ON THIS CARD MAY BE OVERLAYED. THAT IS, FACTORS  -
CN            DEFINED ON LATER TYPE 37 CARDS SUPERSEDE DATA FOR     -
CN            COMPOSITIONS PREVIOUSLY SPECIFIED.                    -
CN                                                                  -
CN            THE ENERGY CONVERSION FACTOR FOR ANY COMPOSITION NOT  -
CN            REFERENCED ON A TYPE 37 OR TYPE 38 CARD WILL BE       -
CN            DETERMINED FROM DATA IN ISOTXS.                       -
```

```
C                                                                           -
C---------------------------------------------------------------------------

C---------------------------------------------------------------------------
CR            CAPTURE ENERGY CONVERSION FACTOR DATA (TYPE 38)               -
C                                                                           -
CL    FORMAT-----(I2,10X,3(A6,E12.5))                                       -
C                                                                           -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY                    -
CD  =  =======  ==========================================================-
CD  1  1-2      38                                                          -
CD                                                                          -
CD  2  13-18    COMPOSITION LABEL.                                          -
CD                                                                          -
CD  3  19-30    ENERGY CONVERSION FACTOR FOR THIS COMPOSITION               -
CD             (CAPTURES/WATT-SEC.).                                        -
CD                                                                          -
CD  4  31-36    COMPOSITION LABEL.                                          -
CD                                                                          -
CD  5  37-48    ENERGY CONVERSION FACTOR FOR THIS COMPOSITION               -
CD             (CAPTURES/WATT-SEC.).                                        -
CD                                                                          -
CD  6  49-54    COMPOSITION LABEL.                                          -
CD                                                                          -
CD  7  55-66    ENERGY CONVERSION FACTOR FOR THIS COMPOSITION               -
CD             (CAPTURES/WATT-SEC.).                                        -
C                                                                           -
CN             IF TYPE 37 OR TYPE 38 CARDS ARE PROVIDED FOR A               -
CN             A PARTICULAR COMPOSITION, THE ENERGY CONVERSION              -
CN             FACTORS IN DATA SET ISOTXS WILL BE IGNORED FOR THAT          -
CN             COMPOSITION, AND THE DATA ON THE TYPE 37 AND TYPE 38         -
CN             CARDS WILL BE USED INSTEAD.                                  -
CN                                                                          -
CN             IF THE FIRST LABEL (COLS. 13-18) ON A TYPE 38 CARD IS        -
CN             BLANK, THE ASSOCIATED CONVERSION FACTOR WILL BE              -
CN             ENTERED FOR ALL COMPOSITIONS.                                -
CN                                                                          -
CN             IF COLS. 31-36 ARE BLANK THE DATA IN COLS. 37-66 ARE         -
CN             NEGLECTED.  IF COLS. 49-54 ARE BLANK THE DATA IN             -
CN             COLS. 55-66 ARE NEGLECTED.                                   -
CN                                                                          -
CN             DATA ON THIS CARD MAY BE OVERLAYED. THAT IS, FACTORS         -
CN             DEFINED ON LATER TYPE 38 CARDS SUPERSEDE DATA FOR            -
CN             COMPOSITIONS PREVIOUSLY SPECIFIED.                           -
CN                                                                          -
CN             THE ENERGY CONVERSION FACTOR FOR ANY COMPOSITION NOT         -
CN             REFERENCED ON A TYPE 37 OR TYPE 38 CARD WILL BE              -
CN             DETERMINED FROM DATA IN ISOTXS.                              -
C                                                                           -
C---------------------------------------------------------------------------

C---------------------------------------------------------------------------
CR            NUCLIDE SET ASSIGNMENTS (TYPE 39)                             -
C                                                                           -
CL    FORMAT-----(I2,4X,11A6)                                               -
C                                                                           -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY                    -
CD  =  =======  ==========================================================-
CD  1  1-2      39                                                          -
CD                                                                          -
CD  2  7-12     NUCLIDE SET LABEL.                                          -
CD                                                                          -
CD  3  13-18    ISOTOPE TO BE ASSIGNED TO THIS NUCLIDE SET.                 -
CD                                                                          -
CD  4  19-24    ISOTOPE TO BE ASSIGNED TO THIS NUCLIDE SET.                 -
CD                                                                          -
CD  5  25-30    ISOTOPE TO BE ASSIGNED TO THIS NUCLIDE SET.                 -
CD                                                                          -
CD  6  31-36    ISOTOPE TO BE ASSIGNED TO THIS NUCLIDE SET.                 -
CD                                                                          -
```

```
CD   7   37-42     ISOTOPE TO BE ASSIGNED TO THIS NUCLIDE SET.          -
CD                                                                      -
CD   8   43-48     ISOTOPE TO BE ASSIGNED TO THIS NUCLIDE SET.          -
CD                                                                      -
CD   9   49-54     ISOTOPE TO BE ASSIGNED TO THIS NUCLIDE SET.          -
CD                                                                      -
CD  10   55-60     ISOTOPE TO BE ASSIGNED TO THIS NUCLIDE SET.          -
CD                                                                      -
CD  11   61-66     ISOTOPE TO BE ASSIGNED TO THIS NUCLIDE SET.          -
CD                                                                      -
CD  12   67-72     ISOTOPE TO BE ASSIGNED TO THIS NUCLIDE SET.          -
C                                                                       -
CN                 NUCLIDE SET ASSIGNMENTS ARE OPTIONAL. THEIR USE MAY  -
CN                 REDUCE THE SIZE OF THE CCCC ATOM DENSITY FILE (ZNATDN) -
CN                 AND, THEREFORE, THE RUNNING TIME FOR CROSS SECTION    -
CN                 HOMOGENIZATION.                                       -
CN                                                                       -
CN                 ALL ISOTOPES USED IN A PARTICULAR ZONE OR A           -
CN                 PARTICULAR SUBZONE MUST BE ASSIGNED TO THE SAME        -
CN                 NUCLIDE SET.                                           -
CN                                                                       -
CN                 WHEN NO TYPE 39 CARDS ARE PROVIDED, ALL ISOTOPES ARE   -
CN                 ASSIGNED TO A SINGLE NUCLIDE SET.                      -
C                                                                        -
C----------------------------------------------------------------------


C----------------------------------------------------------------------
CR            SOURCE EDIT AND SYNTHESIS TRIAL FUNCTION SOURCE          -
CR            SPECIFICATION (TYPE 40)                                  -
C                                                                      -
CL     FORMAT-----(I2,4X,4I6)                                          -
C                                                                      -
CD  #   COLUMNS           CONTENTS...IMPLICATIONS, IF ANY              -
CD  =   =======   =======================================================-
CD  1   1-2       40                                                   -
CD                                                                     -
CD  2   7-12      EDIT FLAG FOR POINTWISE INHOMOGENEOUS SOURCE         -
CD                   0, NO EDITS (DEFAULT).                            -
CD                   1, PRINT EDITS.                                   -
CD                   2, WRITE EDITS TO AUXILIARY OUTPUT FILE.          -
CD                   3, WRITE EDITS TO BOTH PRINT AND AUXILIARY OUTPUT -
CD                      FILE.                                          -
CD                                                                     -
CD  3   13-18     RTFLUX FILE VERSION NUMBER FOR A SYNTHESIS TRIAL     -
CD                FUNCTION SOURCE.                                     -
CD                   S(X,Y,Z,G)=D(X,Y,Z,G)*FLUX(X,Y,Z,G)              -
CD                WHERE D IS A DIFFUSION COEFFICIENT AND FLUX IS A FLUX -
CD                (OR ADJOINT FLUX) FROM AN INPUT RTFLUX (OR ATFLUX)   -
CD                FILE.  USE A NEGATIVE VALUE FOR ATFLUX.  SET TO ZERO -
CD                WHEN ANOTHER TYPE OF SOURCE IS REQUIRED.             -
CD                                                                     -
CD  4   19-24     VERSION NUMBER OF GEODST FILE SPECIFYING COMPOSITION -
CD                DISTRIBUTION REQUIRED FOR A SYNTHESIS TRIAL FUNCTION -
CD                SOURCE.  0 OR 1 IMPLIES THE GEOMETRY DEFINED BY THE  -
CD                CURRENT A.NIP3 DATASET.  THIS PARAMETER IS USED ONLY -
CD                WHEN THE FLUX FILE VERSION IN COLS. 13-18 IS .GE. 1. -
CD                                                                     -
CD  5   25-30     WORD LENGTH PARAMETER FOR THE FIXSRC FILE SOURCE     -
CD                DISTRIBUTION.  ON SINGLE-WORD-LENGTH MACHINES        -
CD                (E.G. CDC) THIS INPUT FIELD IS IGNORED.  ON DOUBLE-  -
CD                WORD-LENGTH MACHINES A VALUE OF 1 WILL PRODUCE A     -
CD                SHORT-WORD (I.E. REAL*4) FILE, A VALUE OF 2 WILL     -
CD                PRODUCE A DOUBLE-WORD (I.E. REAL*8) FILE.  THE DIF3D -
CD                CODE REQUIRES A DOUBLE-WORD FILE  ON DOUBLE-WORD-    -
CD                LENGTH MACHINES.  (DEFAULT = 2 ON DOUBLE-WORD-LENGTH -
CD                MACHINES)                                            -
C                                                                      -
C----------------------------------------------------------------------


C----------------------------------------------------------------------
```

```
CR            NATURAL DECAY INHOMOGENEOUS SOURCE SPECIFICATIONS          -
CR            (TYPE 41)                                                  -
C                                                                        -
CL     FORMAT-----(I2,4X,2(A6,E12.5,A6))                                 -
C                                                                        -
CD  #   COLUMNS            CONTENTS...IMPLICATIONS, IF ANY               -
CD  =   =======   ========================================================-
CD  1   1-2       41                                                     -
C                                                                        -
CD  2   7-12      ISOTOPE LABEL                                          -
CD                                                                       -
CD  3   13-24     DECAY CONSTANT                                         -
CD                                                                       -
CD  4   25-30     SPECTRUM LABEL OF SPECTRUM TO BE USED WITH THIS        -
CD                ISOTOPE (SEE CARD TYPE 42)                             -
CD                                                                       -
CD  5   31-36     ISOTOPE LABEL                                          -
CD                                                                       -
CD  6   37-48     DECAY CONSTANT                                         -
CD                                                                       -
CD  7   49-54     SPECTRUM LABEL OF SPECTRUM TO BE USED WITH THIS        -
CD                ISOTOPE (SEE CARD TYPE 42)                             -
C                                                                        -
CN                WHEN THERE ARE TYPE 41 CARDS A FIXSRC FILE WILL BE     -
CN                CREATED CONTAINING THE DISTRIBUTED SOURCE              -
CN                     S(X,Y,Z,G) = SUM OVER ISOTOPES (I) OF            -
CN                       SCHI(G,I)*DC(I)*ATND(X,Y,Z,I)                  -
CN                WHERE SCHI IS AN ISOTOPE SOURCE SPECTRUM (SEE THE TYPE -
CN                42 CARDS), DC IS THE DECAY CONSTANT AND ATND IS THE    -
CN                ISOTOPE NUMBER DENSITY.                                -
CN                                                                       -
CN                AS MANY TYPE 41 CARDS SHOULD BE PROVIDED AS ARE        -
CN                NECESSARY TO SPECIFY ALL ISOTOPES REQUIRED.            -
CN                                                                       -
CN                WHEN THE SPECTRUM LABEL IS BLANK THE SOURCE WILL BE    -
CN                COMPUTED WITH THE SPECTRUM EQUAL TO 1.0 IN ALL GROUPS. -
C                                                                        -
C------------------------------------------------------------------------



C------------------------------------------------------------------------
CR            SOURCE SPECTRUM DATA (TYPE 42)                             -
C                                                                        -
CL     FORMAT-----(I2,4X,A6,5E12.5)                                     -
C                                                                        -
CD  #   COLUMNS            CONTENTS...IMPLICATIONS, IF ANY               -
CD  =   =======   ========================================================-
CD  1   1-2       42                                                     -
CD                                                                       -
CD  2   7-12      SPECTRUM LABEL                                         -
CD                                                                       -
CD  3   13-24     GROUP MULTIPLIER (SPECTRUM), FIRST GROUP.              -
CD                                                                       -
CD  4   25-36     GROUP MULTIPLIER (SPECTRUM), NEXT GROUP.               -
CD                                                                       -
CD  5   37-48     GROUP MULTIPLIER (SPECTRUM), NEXT GROUP.               -
CD                                                                       -
CD  6   49-60     GROUP MULTIPLIER (SPECTRUM), NEXT GROUP.               -
CD                                                                       -
CD  7   61-72     GROUP MULTIPLIER (SPECTRUM), NEXT GROUP.               -
C                                                                        -
CN                AS MANY TYPE 42 CARDS, FIVE ENERGY GROUPS PER CARD,    -
CN                SHOULD BE PROVIDED AS ARE NECESSARY TO SPECIFY ALL THE -
CN                SPECTRA NEEDED FOR THE NATURAL DECAY SOURCE            -
CN                CALCULATION.  THE FIRST TYPE 42 CARD MUST HAVE A       -
CN                NON-BLANK SPECTRUM LABEL.  A REPEATED SPECTRUM LABEL   -
CN                IMPLIES A CONTINUATION OF THE LAST CARD WITH THE SAME  -
CN                LABEL.  A BLANK SPECTRUM LABEL IMPLIES A CONTINUATION  -
CN                OF THE SPECTRUM ON THE PREVIOUS TYPE 42 CARD.          -
CN                                                                       -
CN                WHEN THE NUMBER OF DATA FOR A PARTICULAR SPECTRUM IS   -
CN                LESS THAN THE TOTAL NUMBER OF ENERGY GROUPS, THE       -
```

107

```
CN                REMAINING ELEMENTS OF THE SPECTRUM ARE SET TO ZERO.    -
CN                WHEN THE NUMBER OF DATA IS GREATER THAN THE NUMBER     -
CN                OF GROUPS THE SURPLUS ELEMENTS ARE IGNORED.            -
C                                                                        -
C------------------------------------------------------------------------


C------------------------------------------------------------------------
CR           GRAPHICS OUTPUT CONTROL (TYPE 43)                           -
C                                                                        -
CL     FORMAT-----(I2,4X,I6,3E12.4,3I6)                                  -
C                                                                        -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY                  -
CD  =  =======  =======================================================-
CD  1  1-2      43                                                       -
CD                                                                       -
CD  2  7-12     GRAPHICS OUTPUT SENTINEL FOR MAP                         -
CD                0...NO GRAPHICS (DEFAULT)                              -
CD                1...GENERATE MAP                                       -
CD                                                                       -
CD  3  13-24    HEIGHT OF GRAPHICS OUTPUT FIELD (DEFAULT=11.0 INCHES)    -
CD                                                                       -
CD  4  25-36    WIDTH OF GRAPHICS OUTPUT FIELD (DEFAULT=11.0 INCHES)     -
CD                                                                       -
CD  5  37-48    FOR TRIANGULAR AND HEXAGONAL GEOMETRIES - THIS FIELD     -
CD                CONTAINS THE FLAT-TO-FLAT DISTANCE ACROSS EACH         -
CD                HEXAGON, IN INCHES (DEFAULT = 0.5 INCHES)              -
CD                                                                       -
CD                FOR ORTHOGONAL GEOMETRIES - THIS FIELD CONTAINS THE    -
CD                MINIMUM REDUCTION ALLOWED FOR LABELS (DEFAULT = 0.5).  -
CD                SEE THE NOTE BELOW.                                    -
C                                                                        -
CD  6  49-54    PRINTER PLOTTER SENTINEL - HEXAGONAL MAP ONLY            -
CD                1...FLAT-TO-FLAT HEXAGON DIMENSION = 8 ROWS            -
CD                2...FLAT-TO-FLAT HEXAGON DIMENSION = 6 ROWS (DEFAULT)  -
CD                                                                       -
CD  7  55-60    MAXIMUM NO. OF ROWS IN PRINTER-PLOTTER FIELD -           -
CD                HEXAGONAL MAP ONLY (DEFAULT = 48)                      -
CD                                                                       -
CD  8  61-66    MAXIMUM NO. OF PRINT COLUMNS IN PRINTER-PLOTTER FIELD    -
CD                - HEXAGONAL MAP ONLY (DEFAULT = 130)                   -
C                                                                        -
CN                THE GRAPHICS OPTION MAY NOT BE AVAILABLE IN ALL        -
CN                VERSIONS OF THE INPUT PROCESSOR GNIP4C.                -
CN                                                                       -
CN                THIS CARD CONTROLS THE FORMAT OF THE PRINTER-PLOTTER   -
CN                OUTPUT FOR HEXAGONAL MAPS BUT DOES NOT ACTUALLY        -
CN                TRIGGER THE PRINTER MAP.  THAT IS DONE BY A SENTINEL   -
CN                ON THE TYPE 02 CARD.  THIS CARD HAS NO EFFECT ON THE   -
CN                PRINTER-PLOTTER MAP OF ORTHOGONAL GEOMETRY MODELS.     -
CN                                                                       -
CN                FOR TRIANGULAR AND HEXAGONAL GEOMETRIES THE SCALE      -
CN                OF THE PLOT IS DETERMINED BY THE FLAT-TO-FLAT DISTANCE -
CN                IN COLS. 37-48.  THE SIZE OF THE GRAPHICS PAGE IS SET  -
CN                BY THE DATA IN COLS. 13-36.  THE CODE GENERATES AS     -
CN                MANY PAGES OF GRAPHICS OUTPUT AS IT TAKES TO COVER THE -
CN                ENTIRE MAP.  LABELS ARE CENTERED IN EACH HEXAGON, AND  -
CN                THE CHARACTER SIZE IS A FIXED FRACTION (1/8) OF THE    -
CN                FLAT-TO-FLAT DISTANCE.                                 -
CN                                                                       -
CN                FOR ORTHOGONAL GEOMETRIES THE SCALE OF THE PLOT IS     -
CN                SET BY THE CODE SO THAT THE ENTIRE MAP IS FORCED       -
CN                TO FIT IN A SINGLE GRAPHICS PAGE.  THE MAXIMUM         -
CN                SIZE OF THE GRAPHICS PAGE IS SET BY THE DATA IN        -
CN                COLS. 13-36.  LABELS WITH 0.1 INCH CHARACTER HEIGHT    -
CN                ARE PLACE IN REGIONS AS LONG AS THERE IS ROOM.  IF THE -
CN                REGION IS TOO SMALL, THE LABEL IS REDUCED IN SIZE.  IF -
CN                TO FIT IN THE REGION THE LABEL SIZE MUST BE REDUCED    -
CN                BY A FACTOR SMALLER THAN THE NUMBER IN COLS. 37-48     -
CN                NO LABEL IS DRAWN.  WHEN THE NUMBER IN COLS. 37-48     -
CN                IS GREATER THAN 1.0 NO LABELS ARE DRAWN.               -
C                                                                        -
```

108

```
C----------------------------------------------------------------------
C----------------------------------------------------------------------
CR          ASSIGNMENT OF REGIONS TO CONTROL ROD BANKS (TYPE 44)       -
C                                                                      -
CL     FORMAT-----(I2,4X,11A6)                                         -
C                                                                      -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY                -
CD  =  =======  =============================================================
CD  1  1-2      44                                                     -
CD                                                                     -
CD  2  7-12     CONTROL ROD BANK LABEL (REPEATED ON ADDITIONAL         -
CD              TYPE 44 CARDS IF NECESSARY).                           -
CD                                                                     -
CD  3  13-18    REGION LABEL OR AREA LABEL DEFINING REGION(S)          -
CD              AT THE TIP OF THE MOVEABLE PORTION OF THE ROD(S) IN     -
CD              THE SPECIFIED CONTROL ROD BANK.                        -
CD                                                                     -
CD  4  19-24    REGION LABEL OR AREA LABEL DEFINING REGION(S)          -
CD              AT THE TIP OF THE MOVEABLE PORTION OF THE ROD(S) IN     -
CD              THE SPECIFIED CONTROL ROD BANK.                        -
CD                                                                     -
CD  5  25-30    REGION LABEL OR AREA LABEL DEFINING REGION(S)          -
CD              AT THE TIP OF THE MOVEABLE PORTION OF THE ROD(S) IN     -
CD              THE SPECIFIED CONTROL ROD BANK.                        -
CD                                                                     -
CD  6  31-36    REGION LABEL OR AREA LABEL DEFINING REGION(S)          -
CD              AT THE TIP OF THE MOVEABLE PORTION OF THE ROD(S) IN     -
CD              THE SPECIFIED CONTROL ROD BANK.                        -
CD                                                                     -
CD  7  37-42    REGION LABEL OR AREA LABEL DEFINING REGION(S)          -
CD              AT THE TIP OF THE MOVEABLE PORTION OF THE ROD(S) IN     -
CD              THE SPECIFIED CONTROL ROD BANK.                        -
CD                                                                     -
CD  8  43-48    REGION LABEL OR AREA LABEL DEFINING REGION(S)          -
CD              AT THE TIP OF THE MOVEABLE PORTION OF THE ROD(S) IN     -
CD              THE SPECIFIED CONTROL ROD BANK.                        -
CD                                                                     -
CD  9  49-54    REGION LABEL OR AREA LABEL DEFINING REGION(S)          -
CD              AT THE TIP OF THE MOVEABLE PORTION OF THE ROD(S) IN     -
CD              THE SPECIFIED CONTROL ROD BANK.                        -
CD                                                                     -
CD 10  55-60    REGION LABEL OR AREA LABEL DEFINING REGION(S)          -
CD              AT THE TIP OF THE MOVEABLE PORTION OF THE ROD(S) IN     -
CD              THE SPECIFIED CONTROL ROD BANK.                        -
CD                                                                     -
CD 11  61-66    REGION LABEL OR AREA LABEL DEFINING REGION(S)          -
CD              AT THE TIP OF THE MOVEABLE PORTION OF THE ROD(S) IN     -
CD              THE SPECIFIED CONTROL ROD BANK.                        -
CD                                                                     -
CD 12  67-72    REGION LABEL OR AREA LABEL DEFINING REGION(S)          -
CD              AT THE TIP OF THE MOVEABLE PORTION OF THE ROD(S) IN     -
CD              THE SPECIFIED CONTROL ROD BANK.                        -
C                                                                      -
CN              ALL REGIONS IN A ROD CHANNEL ABOVE THE ROD TIP         -
CN              MOVE TOGETHER.  ALL REGIONS BELOW THE TIP ARE          -
CN              STATIONARY, AND ARE REPLACED BY ROD REGIONS AS THE     -
CN              ROD MOVES DOWN.  THE TOPMOST REGION IN THE ROD         -
CN              EXPANDS AS THE ROD MOVES DOWN FROM ITS INITIAL         -
CN              POSITION.  THE REGION JUST BELOW THE INITIAL ROD-TIP   -
CN              POSITION EXPANDS AS THE ROD MOVES UP FROM ITS          -
CN              ORIGINAL POSITION.                                     -
CN                                                                     -
CN              THE LOWER BOUNDARY OF ALL ROD-TIP REGIONS WHICH DEFINE -
CN              RODS ASSIGNED TO A PARTICULAR CONTROL ROD BANK MUST    -
CN              BE AT THE SAME AXIAL POSITION.  "AXIAL" REFERS TO THE  -
CN              Z-DIMENSION IN RZ, XYZ, AND HEX-Z, AND TO THE Y        -
CN              DIMENSION IN XY.  THUS FOR THE (R-Z E.G.) GEOMETRY     -
CN              PICTURED BELOW,                                        -
CN                                                                     -
CN              -------------------------------------------           -
CN              |        |        |        |        |        |        |    -
```

109

```
CN               |       |  R2   |       |  R6   |  CR21 |        -
CN               |       |       |       |       |       |        -
CN               |       |-------|  CR11 |-------|-------|        -
CN               |       |       |       |       |       |        -
CN               |       |  R3   |       |       |  CR22 |        -
CN               |       |       |       |       |       |        -
CN               |  R1   |-------|-------|  R7   |-------|        -
CN               |       |       |       |       |       |        -
CN               |       |  R4   |  CR12 |       |  CR23 |        -
CN               |       |       |       |       |       |        -
CN               |       |-------|-------|-------|-------|        -
CN               |       |       |       |       |       |        -
CN               |       |  R5   |  C1   |  R8   |  C2   |        -
CN               |       |       |       |       |       |        -
CN               -----------------------------------------        -
CN                                                                -
CN                                                                -
CN               THE FOLLOWING TYPE 44 CARDS (GIVEN IN FREE FORMAT -
CN               STYLE INPUT) WOULD RESULT IN A FATAL ERROR        -
CN                                                                -
CN                   44 BANK1 CR12 CR22                            -
CN                                                                -
CN               WHEREAS                                          -
CN                                                                -
CN                   44 BANK1 CR12 CR23                            -
CN                                                                -
CN               WOULD BE ACCEPTABLE.  ALSO, A ROD BANK MAY NOT BE -
CN               SPECIFIED USING MORE THAN ONE REGION IN A PARTICULAR -
CN               VERTICAL CHANNEL.  THUS                          -
CN                                                                -
CN                   44 BANK1 CR22 CR23                            -
CN                                                                -
CN               WOULD LEAD TO A FATAL INPUT ERROR.               -
CN                                                                -
CN               NOTE THAT SINCE IT MUST BE ASSUMED THAT A CONTROL ROD -
CN               BANK WILL BE MOVED DURING THE COURSE OF A PROBLEM, -
CN               AT LEAST ONE REGION MUST BE DEFINED BELOW EACH REGION -
CN               SPECIFIED IN COLS. 13-72.  THUS, THE FOLLOWING TYPE -
CN               44 CARD WOULD NOT BE ACCEPTABLE FOR THE GEOMETRY GIVEN -
CN               ABOVE                                            -
CN                   44 BANK1 C1                                  -
CN                                                                -
CN               AN AREA LABEL IN COLS. 13-72 IMPLIES ALL THE REGIONS -
CN               ASSIGNED TO THAT AREA.  AREAS ARE DEFINED ON THE -
CN               TYPE 07 CARD OF DATASET A.NIP3.                  -
CN                                                                -
CN               THE FIRST BLANK REGION LABEL ENCOUNTERED TERMINATES -
CN               READING OF THE DATA ON THAT PARTICULAR TYPE 44 CARD. -
CN                                                                -
CN               NOTE THAT A BLANK CONTROL ROD BANK LABEL IS ACCEPTABLE.-
C                                                                 -
C-----------------------------------------------------------------

CEOF
```

110

```
C*********************************************************************
C                                                                    -
C                       Latest version 12/20/01                      -
C                                                                    -
CF            A.STP027                                               -
CE            FUEL CYCLE STANDARD PATH BCD INPUT                     -
C                                                                    -
CN                       THIS IS A USER SUPPLIED BCD DATA SET.  THE  -
CN                       LIST FOR EACH RECORD IS GIVEN IN TERMS OF THE -
CN                       BCD FORMAT OF THE DATA CARD.  COLUMNS 1-2   -
CN                       NORMALLY CONTAIN THE CARD TYPE NUMBER.      -
CN                                                                   -
CN                       A.STP027 NEED NOT BE SUPPLIED AT ALL - OR   -
CN                       ANY CARD TYPE MAY BE OMITTED.               -
CN                                                                   -
C                                                                    -
C                                                                    -
CN                   ***  CARD TYPE DIRECTORY  ***                   -
CN                                                                   -
CN     TYPE                      CONTENTS                            -
CN     ====     =======================================             -
CN     01     GENERAL PROBLEM SPECIFICATIONS                        -
CN     02     GENERAL EDIT SPECIFICATIONS                           -
CN     03     SELECTIVE EDIT SPECIFICATIONS                         -
CN     04     A.DIF3D TYPE 02 CARD MODIFICATIONS                    -
CN     05     LOGIC FLOW MODIFICATIONS                              -
C                                                                    -
C*********************************************************************


C--------------------------------------------------------------------
CR            GENERAL PROBLEM SPECIFICATIONS (TYPE 01)               -
C                                                                    -
CL     FORMAT-----(I2,4X,11I6)                                       -
C                                                                    -
CD  #   COLUMNS          CONTENTS...IMPLICATIONS, IF ANY             -
CD  =   =======   =========================================================-
CD  1   1-2       01                                                 -
CD                                                                   -
CD  2   7-12      0...DO NOT ACTIVATE ERRSET (DEFAULT).              -
CD                1...ACTIVATE ERRSET TO FORCE AN ABEND UPON ENCOUNTERING-
CD                    ANY ERROR DETECTED BY THE FORTRAN EXTENDED ERROR   -
CD                    HANDLING FACILITY.                             -
CD                                                                   -
CD  3   13-18     0...NORMAL PROBLEM (DEFAULT).                      -
CD                1...EXECUTION ONLY THROUGH THE FUEL CYCLE INPUT    -
CD                    PROCESSOR (FCI002) FOR DEBUGGING OF A NEW CASE.   -
CD                    NOT PERTINENT FOR A RESTART PROBLEM.           -
CD                                                                   -
CD  4   19-24     0...DISABLE CRITICALITY SEARCH SPECIFIED BY        -
CD                    A.NIP3 (DEFAULT).                              -
CD                1...ENABLE CRITICALITY SEARCH.                     -
CD                                                                   -
CD  5   25-30     0...EQUILIBRIUM PROBLEM (DEFAULT).                 -
CD                1...NONEQUILIBRIUM PROBLEM.                        -
CD                                                                   -
CD  6   31-36     0...ENABLE NEUTRONICS (DEFAULT).                   -
CD                1...DISABLE NEUTRONICS - I.E. ASSUME THE ORIGINAL FLUX -
CD                    DISTRIBUTION, AS COMPUTED BY THE FIRST NEUTRONICS  -
CD                    CALCULATION, OR AS GIVEN BY THE RZFLUX DATA SET -
CD                    THAT IS PROVIDED IN THE BLOCK=OLD DATA SETS, IS -
CD                    APPLICABLE THROUGHOUT THE PROBLEM.  THE        -
CD                    FLUX LEVEL IS RENORMALIZED AT EACH SUBINTERVAL SO -
CD                    AS TO MAINTAIN A CONSTANT POWER LEVEL. PERTINENT -
CD                    ONLY FOR NONEQUILIBRIUM PROBLEMS (I.E. A 1 IN COLS.-
CD                    25-30)                                         -
CD                                                                   -
CD                NOTES ON THE USE OF THIS OPTION:                   -
CD                1. COLS. 31-36 MUST BE 0 IF COLS. 25-30 ARE 0.     -
CD                2. IF COLS. 31-36 ARE 1, THEN COLS. 61-66 ON CARD  -
CD                   TYPE 02 OF DATA SET A.BURN SHOULD BE 0.         -
CD                3. A NEUTRONICS SOLUTION IS ALWAYS OBTAINED AT THE -
```

111

```
CD                      END OF THE BURN STEP EVEN IF COLS. 31-36 ARE 1.    -
CD                   4. IF RZFLUX APPEARS AMONG THE BLOCK=OLD DATA SETS,    -
CD                      COLS. 31-36 ARE IGNORED AND THE SUPPLIED RZFLUX IS  -
CD                      USED THROUGHOUT THE PROBLEM WITH RENORMALIZATION TO -
CD                      MAINTAIN CONSTANT POWER.                            -
CD                   5. WARNING! IN THE CASE OF A RESTART PROBLEM,          -
CD                      THE RZFLUX DATA SET IS AUTOMATICALLY                -
CD                      RECREATED FROM THE RESTART DATA SET RFILES. HENCE   -
CD                      ANY SUPPLIED RZFLUX DATA SET WILL BE OVERWRITTEN.   -
CD                                                                         -
CD  7  37-42    0...CREATE A CONDENSED VERSION OF DATA SET ISOTXS AND       -
CD                    A CORRESPONDING VERSION OF DATA SET NDXSRF            -
CD               1...USE THE ORIGINAL ISOTXS AND NDXSRF DATA SETS           -
CD                                                                         -
CD  8  43-48    0...NO PERIODIC SAVES (DEFAULT).                            -
CD               N...MAKE A PERIODIC SAVE EVERY X/N MINUTES WHERE X IS      -
CD                    THE PROBLEM JOB TIME AS PUNCHED ON THE JOB CARD.      -
CD                                                                         -
CD  9  49-54    0...NORMAL PROBLEM (DEFAULT).                               -
CD               N...TERMINATE PROBLEM WITH A WRAPUP AFTER N NEUTRONICS     -
CD                    SOLUTIONS HAVE BEEN COMPLETED.                        -
CD              -N...MAKE A PERIODIC SAVE AFTER EVERY N NEUTRONICS          -
CD                    SOLUTIONS.                                            -
CD                                                                         -
CD 10  55-60    0...DO NOT EXECUTE A STANDALONE MASS FLOW SUMMARY EDIT      -
CD               1...EXECUTE A STANDALONE MASS FLOW SUMMARY EDIT            -
CD                                                                         -
CD 11  61-66    AVAILABLE TIME FOR THE PROBLEM IN SECONDS                   -
CD              (DEFAULT=100000)                                            -
CD                                                                         -
CD 12  66-72    0...NORMAL PROBLEM (DEFAULT).                               -
CD               1...HIGH BURNUP PROBLEM.                                   -
C                                                                          -
CN              THE AVAILABLE TIME IN COLS. 61-66 SHOULD NORMALLY NOT       -
CN              BE SPECIFIED SINCE THE REMAINING LIMITING TIME FOR THE      -
CN              PROBLEM IS OBTAINED FROM THE SYSTEM.  HOWEVER, IF           -
CN              COLS. 61-66 ARE NOT 0, THE VALUE SUPPLIED WILL BE USED      -
CN              TO COMPUTE A VALUE FOR THE REMAINING LIMITING TIME          -
CN              WHICH WILL BE COMPARED WITH THE VALUE OBTAINED FROM         -
CN              THE SYSTEM.  THE DETERMINATION OF WHEN A PROBLEM            -
CN              WRAPUP IS REQUIRED WILL MAKE USE OF THE SMALLER OF          -
CN              THE TWO VALUES OF THE REMAINING LIMITING TIME.              -
CN              NOTE THAT WHEN A LEGITIMATE VALUE FOR THE REMAINING         -
CN              LIMITING TIME CAN NOT BE OBTAINED FROM THE SYSTEM           -
CN              (AS FOR EXAMPLE IN THE CASE                                 -
CN              OF REBUS-PC) USE OF COLS. 61-66 IS ESSENTIAL TO AVOID       -
CN              EXCEEDING THE AVAILABLE TIME FOR A PROBLEM WITHOUT          -
CN              OBTAINING A RESTART DATA SET.                               -
CN                                                                         -
CN              THE USE OF THE PERIODIC SAVE OPTION DOES NOT DISABLE        -
CN              THE SAVE WHICH IS MADE IF A JOB RUNS OUT OF TIME.           -
CN                                                                         -
CN              A RESTART PROBLEM IS INDICATED BY PUTTING THE               -
CN              DATA SETS RFILES AND RESTRT IN THE 'BLOCK=OLD'              -
CN              DATA SET INITIALIZATION BLOCK.                              -
CN                                                                         -
CN              USING A 0 IN COLS. 37-42 WILL PRODUCE A SUBSET OF DATA      -
CN              SET ISOTXS ON LOGICAL UNIT NUMBER 46 WHICH CONTAINS         -
CN              ONLY THE ISOTOPES USED IN THE PROBLEM, AND WHICH            -
CN              CONTAINS ONLY A TOTAL SCATTERING MATRIX. ALSO,             -
CN              A CONSISTENT NDXSRF DATA SET WILL BE PRODUCED ON            -
CN              LOGICAL UNIT NUMBER 54.                                     -
CN              THIS CONDENSATION WILL REDUCE THE I/O TIME,                 -
CN              ESPECIALLY FOR EQUILIBRIUM PROBLEMS.                        -
CN              NOTE THAT IF COLS. 37-42 ARE 0, THE CONSISTENT DATA         -
CN              SETS ISOTXS AND NDXSRF ARE ON LOGICAL UNIT NUMBERS          -
CN              46 AND 54, RESPECTIVELY.  IF COLS. 37-42 ARE 1, THE         -
CN              CONSISTENT LOGICAL UNIT NUMBERS ARE 35 AND 37.              -
CN                                                                         -
CN              IF COLS. 55-60 ARE 1, ONLY THE STANDALONE MASS FLOW        -
CN              SUMMARY EDIT WILL BE EXECUTED AND DATA SET A.MASFLO         -
CN              SHOULD BE PROVIDED.  A NORMAL EQUILILIBRIUM REBUS-PC        -
```

```
CN                  PROBLEM WILL PROVIDE A MASS FLOW SUMMARY EDIT AS PART  -
CN                  OF ITS NORMAL OUTPUT DEPENDING UPON THE DATA IN DATA   -
CN                  SET A.BURN CARD TYPES 31-34.  IF COLS. 31-36 ON DATA   -
CN                  SET A.STP027 CARD TYPE 02 ARE 1, THE INPUT FOR THE MASS-
CN                  FLOW SUMMARY EDITS WILL BE PUNCHED FOR SUBSEQUENT USE  -
CN                  WITH A STANDALONE EXECUTION OF THE MASS FLOW SUMMARY.  -
CN                                                                        -
CN                  IF COLS. 67-72 ARE 1, CYCLIC MODE ITERATIONS WILL BE  -
CN                  INITIATED AT THE INTERMEDIATE SEARCH LEVEL FOR AN      -
CN                  EQUILIBRIUM PROBLEM.  THE MAXIMUM NUMBER OF CYCLIC MODE-
CN                  ITERATIONS PERMITTED IS SET BY THE VALUE SUPPLIED IN   -
CN                  COLS. 67-72 ON CARD TYPE 02 OF DATA SET A.BURN.  ALSO, -
CN                  IF COLS. 67-72 ARE 1, FOR AN ENRICHMENT SEARCH, THE    -
CN                  USER SUPPLIED CONVERGENCE CRITERION EPSF ON THE DATA   -
CN                  SET A.BURN TYPE 04 CARD IS TEMPORARILY INCREASED BY A  -
CN                  FACTOR OF 50 DURING THE PRELIMINARY SERACH PROCEDURE.  -
CN                  COLS. 67-72 SHOULD BE SET TO 1 FOR PROBLEMS HAVING     -
CN                  ATOM PERCENT BURNUPS GREATER THAN THE ORDER OF 30 A/O. -
C                                                                         -
C------------------------------------------------------------------------


C------------------------------------------------------------------------
CR            GENERAL EDIT SPECIFICATIONS (TYPE 02)                       -
C                                                                         -
CL     FORMAT-----(I2,4X,11I6)                                            -
C                                                                         -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY                  -
CD  =  =======  ========================================================-
CD  1  1-2      02                                                        -
CD                                                                        -
CD  2  7-12     0...SUPPRESS NEUTRONICS EDITS UNTIL LAST                  -
CD                  PASS (DEFAULT).                                       -
CD               1...ENABLE NEUTRONICS EDITS.                             -
CD                                                                        -
CD  3  13-18    0...ENABLE REACTION SUMMARY EXECUTION (DEFAULT).          -
CD               1...DISABLE REACTION SUMMARY EXECUTION.                  -
CD                                                                        -
CD  4  19-24    0...SUPPRESS EDITS OF OPEN DATA SETS AFTER COMPLETION     -
CD                  OF EACH MODULE (DEFAULT).                             -
CD               1...ENABLE EDITS OF OPEN DATA SETS AFTER COMPLETION      -
CD                  OF EACH MODULE.                                       -
CD                                                                        -
CD  5  25-30    0...SUPPRESS EDITS OF ATOM DENSITIES USED IN EACH         -
CD                  NEUTRONICS SOLUTION (DEFAULT).                        -
CD               1...ENABLE EDITS OF ATOM DENSITIES IN THE FINAL PASS     -
CD                  WITH FULL EDITS.                                      -
CD              -1...ENABLE EDITS OF ATOM DENSITIES AT ALL TIMES.         -
CD               2...SAME AS 1 BUT ONLY EDIT ON AUXILIARY OUTPUT FILE.    -
CD                  NEEDED TO OBTAIN ATOMDEN.BCD AND TYPE13.BCD           -
CD              -2...SAME AS -1 BUT ONLY EDIT ON AUXILIARY OUTPUT FILE.   -
CD                                                                        -
CD  6  31-36    0...DO NOT PUNCH THE MASS FLOW SUMMARY DATA               -
CD                  (DEFAULT)                                             -
CD               1...PUNCH THE MASS FLOW SUMMARY DATA                     -
CD                                                                        -
CD  7  37-42    0...SUPPRESS EDITS OF ZNATDN DATA SET (DEFAULT).          -
CD               1...ENABLE ZNATDN EDITS.                                 -
CD                                                                        -
CD  8  43-48    0...SUPPRESS MASS FLOW EDITS (DEFAULT).                   -
CD               1...ENABLE MASS FLOW EDITS.                              -
CD                                                                        -
CD  9  49-54    0...DO NOT INVOKE UDOIT1 MODULE (DEFAULT).                -
CD               1...INVOKE UDOIT1 MODULE.                                -
CD                                                                        -
CD 10  55-60    0...DO NOT INVOKE UDOIT3 MODULE (DEFAULT).                -
CD               1...INVOKE UDOIT3 MODULE.                                -
CD                                                                        -
CD 11  61-66    0...PROVIDE FULL EDITS FROM ALL MODULES (DEFAULT).        -
CD               1...SUPPRESS EDITS COMPLETELY FROM MODULES MODDIF AND    -
CD                  RESNDX.  ALSO, EDITS FROM MODULE FCC004 WILL BE       -
CD                  REDUCED EXCEPT FOR THE FINAL PASS WITH FULL           -
```

```
CD                     EDITS.                                        -
CD                                                                   -
CD  12 67-72  0...NORMAL PROBLEM (DEFAULT).                          -
CD           1...TERMINATE THE PROBLEM AFTER EXECUTING GNIP4C.       -
C                                                                    -
CN           IF COLS. 43-48 ARE 1, CARD TYPES 32-34 OF DATA SET      -
CN           A.BURN SHOULD BE SUPPLIED.                              -
CN                                                                   -
CN           COLS. 61-66 WILL ONLY AFFECT THE EDITS ROUTED TO        -
CN           THE STANDARD PRINT FILE.  THE AUXILIARY PRINT FILE      -
CN           OUTPUT, IF ANY, WILL CONTAIN ALL OF THE EDITS.          -
CN                                                                   -
C                                                                    -
C--------------------------------------------------------------------

C--------------------------------------------------------------------
CR          SELECTIVE EDIT SPECIFICATIONS (TYPE 03)                  -
C                                                                    -
CL    FORMAT-----(I2,4X,9I6)                                         -
C                                                                    -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY              -
CD  =  =======  ========================================================-
CD  1  1-2      03                                                   -
CD                                                                   -
CD  2  7-12     0...FOR EQUILIBRIUM PROBLEMS, EDIT ATOM DENSITIES AND -
CD                  MASSES OF ACTIVE ISOTOPES IN EACH STAGE OF EACH  -
CD                  PATH, AND FOR NON-EQUILIBRIUM PROBLEMS EDIT ATOM  -
CD                  DENSITIES AND MASSES OF ACTIVE ISOTOPES IN EACH  -
CD                  REGION ONLY ON THE AUXILIARY FILE FT10(DEFAULT). -
CD               1...EDIT ALSO ON THE STANDARD PRINT FILE FT06.      -
CD                  AND TO FILE ATOMDEN.BCD                          -
CD                                                                   -
CD  3  13-18    0...EDIT THE CONVERSION RATIO OF EACH STAGE OF EACH  -
CD                  PATH ONLY ON THE AUXILIARY FILE (DEFAULT).       -
CD               1...EDIT ALSO ON THE STANDARD PRINT FILE.           -
CD                                                                   -
CD  4  19-24    0...EDIT THE FISSILE MASSES OF EACH STAGE OF EACH    -
CD                  PATH ONLY ON THE AUXILIARY FILE (DEFAULT).       -
CD               1...EDIT ALSO ON THE STANDARD PRINT FILE.           -
CD                                                                   -
CD  5  25-30    0...EDIT THE BURNUPS (ATOM % AND MWD/MT), AVERAGE    -
CD                  POWERS OF EACH STAGE OF EACH PATH, INSTANTANEOUS -
CD                  STAGE TOTAL POWERS AND POWER FRACTIONS ONLY ON THE -
CD                  AUXILIARY FILE (DEFAULT).                        -
CD               1...EDIT ALSO ON THE STANDARD PRINT FILE.           -
CD                                                                   -
CD  6  31-36    0...FOR EQUILIBRIUM PROBLEMS, PROVIDE NORMAL EDITS WHEN-
CD                  IN THE FINAL SEARCH WITH FULL EDITS (DEFAULT).   -
CD               1...FOR EQUILIBRIUM PROBLEMS, PROVIDE MINIMAL DIF3D -
CD                  EDITS AND NO SUMMARY EXECUTION WHEN IN THE FINAL -
CD                  SEARCH WITH FULL EDITS AT INTERMEDIATE TIME NODES. -
CD                                                                   -
CD  7  37-42    0...PROVIDE NORMAL EDITS FROM MODULE POLYFI AND CREATE -
CD                  A COMPUTER ASSOCIATES POP METAFILE FOR THE       -
CD                  PLOTTING FITS.                                   -
CD               1...SUPPRESS FITTING DATA EDITS AND DO NOT CREATE A -
CD                  COMPUTER ASSOCIATES POP METAFILE.                -
CD               2...SUPPRESS FITTING DATA EDITS BUT CREATE A COMPUTER -
CD                  ASSOCIATES POP METAFILE.                         -
CD                                                                   -
CD  8  43-48    0...OMIT CALCULATION OF PEAK DISCHARGE BURNUPS       -
CD                  (DEFAULT).                                       -
CC               1...EDIT PEAK DISCHARGE BURNUPS FOR EACH PATH.      -
CD                                                                   -
CD  9  49-54    0...OMIT CALCULATION OF PEAK FAST FLUENCES (DEFAULT). -
CD               1...EDIT PEAK FAST FLUENCES FOR EACH.               -
CD                                                                   -
CD 10  55-60    SUMMARY FILES 1-6 CONTROL.                           -
CD             ENTER A 6 DIGIT NUMBER ABCDEF WHERE                   -
CD                                                                   -
CD             A CONTROLS THE GENERATION OF FILE SUMRY1              -
CD             B CONTROLS THE GENERATION OF FILE SUMRY2              -
```

114

```
CD                     C CONTROLS THE GENERATION OF FILE SUMRY3    -
CD                     D CONTROLS THE GENERATION OF FILE SUMRY4    -
CD                     E CONTROLS THE GENERATION OF FILE SUMRY5    -
CD                     F CONTROLS THE GENERATION OF FILE SUMRY6    -
CD                                                                 -
CD                     THE INTEGERS A, B, C, D, E, AND F SHOULD BE -
CD                     ASSIGNED ONE OF THE FOLLOWING VALUES (LEADING-
CD                     ZEROS ARE IRRELEVANT):                      -
CD                                                                 -
CD                     0...DO NOT CREATE THE FILE (DEFAULT)        -
CD                     1...CREATE THE FILE                         -
CD                                                                 -
CD  11  61-66   SUMMARY FILE 7 CONTROL.                            -
CD                     ENTER A 6 DIGIT NUMBER ABCDEF WHERE         -
CD                                                                 -
CD                     A CONTROLS THE GENERATION OF FILE SUMRY7    -
CD                     B CONTROLS THE GENERATION OF FILE SUMRY8    -
CD                       AND FILE TYPE13.BCD                       -
CD                     C CONTROLS THE GENERATION OF FILE SUMRY9    -
CD                                                                 -
CD                     DIGITS D, E, AND F ARE RESERVED FOR FUTURE  -
CD                     USE AS LATER SUMMARY FILES ARE REQUIRED.    -
CD                                                                 -
CD                     THE INTEGER A SHOULD BE ASSIGNED ONE OF THE -
CD                     FOLLOWING VALUES (LEADING ZEROS ARE IRRELEVANT):-
CD                                                                 -
CD                     0...DO NOT CREATE THE FILE (DEFAULT)        -
CD                     1...CREATE THE FILE                         -
C                                                                  -
CN           CARD TYPE 03 CONTROLS THE EDITS WHEN IN THE FINAL     -
CN           SEARCH WITH FULL EDITS.  NOTE THAT A NON-EQUILIBRIUM  -
CN           PROBLEM IS ALWAYS CONSIDERED TO BE IN THE FINAL SEARCH.-
CN           THE CUMULATIVE EDITS ARE ALWAYS WRITTEN TO THE        -
CN           STANDARD PRINT FILE AND THE AUXILIARY PRINT FILE.     -
CN                                                                 -
CN           FOR EQUILIBRIUM PROBLEMS, THE NORMAL DIF3D EDITS AND  -
CN           SUMMARY EXECUTION ARE ALWAYS PROVIDED AT THE FIRST AND-
CN           LAST TIME NODES EVEN IF COLS. 31-36 ARE 1.  HOWEVER,  -
CN           SUMMARY EXECUTION IS OMITTED AND MINIMAL DIF3D EDITS  -
CN           ARE PROVIDED FOR THE FIRST NEUTRONICS CALCULATION AT  -
CN           THE LAST TIME NODE IF MORE THAN ONE DENSITY ITERATION -
CN           IS SPECIFIED.                                         -
CN                                                                 -
CN           NOTE THAT COLS. 43-48 AND 49-54 MUST NOT CONTAIN A 1  -
CN           FOR PROBLEMS INVOLVING CONTROL ROD SEARCHES SINCE THE -
CN           NUMBER OF MESH POINTS OR THE MESH COMPOSITIONS MAY    -
CN           VARY WHEN THE RODS ARE MOVED, AND THE ALGORITHM       -
CN           BEING USED ASSUMES THAT THE PEAKS CAN BE FOUND BY     -
CN           COMPARING POINT BY POINT THE BEGINNING AND END OF     -
CN           BURN STEP VALUES.                                     -
CN                                                                 -
CN           A PROBLEM WHICH IS RESTARTED USING DATASET RFILES MUST-
CN           HAVE THE SAME SENTINELS SET IN COLS. 43-48 AND 49-54  -
CN           AS WERE SET FOR THE PROBLEM WHICH PERFORMED THE WRAPUP-
CN           AND WROTE DATASET RFILES.                             -
CN                                                                 -
CN           IF COLS. 55-60 CONTAIN 101, THEN FILES SUMRY4 AND     -
CN           SUMRY6 WILL BE GENERATED AND SUMRY1, SUMRY2, SUMRY3,  -
CN           AND SUMRY5 WILL NOT BE GENERATED.  IF COLS. 61-66     -
CN           CONTAIN 100000 SUMRY7 WILL BE GENERATED, BUT SUMRY8   -
CN           AND SUMRY9 WILL NOT BE GENERATED.                     -
C                                                                  -
C-------------------------------------------------------------------


C-------------------------------------------------------------------
CR          A.DIF3D TYPE 02 CARD MODIFICATIONS (TYPE 04)           -
C                                                                  -
CL    FORMAT-----(I2,4X,3I6)                                       -
C                                                                  -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY            -
CD  =  =======  ========================================================-
```

```
CD  1  1-2      04                                                    -
CD                                                                    -
CD  2  7-12     POINTR CONTAINER ARRAY SIZE IN FAST CORE MEMORY (FCM) -
CD              IN REAL*8 WORDS (DEFAULT=10000).                      -
CD                                                                    -
CD  3  13-18    POINTR CONTAINER ARRAY SIZE IN EXTENDED CORE          -
CD              MEMORY (ECM) IN REAL*8 WORDS (DEFAULT=30000).         -
CD                                                                    -
CD  4  19-24    POINTR DEBUGGING EDIT.                                -
CD              0...NO DEBUGGING PRINTOUT (DEFAULT).                  -
CD              1...DEBUGGING DUMP PRINTOUT.                          -
CD              2...DEBUGGING TRACE PRINTOUT.                         -
CD              3...BOTH DUMP AND TRACE PRINTOUT.                     -
C                                                                     -
C--------------------------------------------------------------------


C--------------------------------------------------------------------
CR            LOGIC FLOW MODIFICATIONS (TYPE 05)                      -
C                                                                     -
CL     FORMAT-----(I2,4X,I6)                                          -
C                                                                     -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY               -
CD  =  =======  =======================================================-
CD  1  1-2      05                                                    -
CD                                                                    -
CD  2  7-12     0...NORMAL EXECUTION SEQUENCE                         -
CD                                                                    -
CD              1...FORCE A WRAPUP FOLLOWING EACH FUEL MANAGEMENT STEP -
CD                 FOR NON-EQUILIBRIUM PROBLEMS.  WHEN RESTARTING     -
CD                 SUCH A PROBLEM, THE LOGIC SEQUENCE WILL BE THE     -
CD                 SAME AS FOR THE CASE WHEN COLS. 7-12 ARE 0.        -
CD              2...NO WRAPUP EVER.                                   -
CD  3  13-18    0...DIF3D (DEFAULT) USED FOR NEUTRONICS               -
CD              1...MCNP, OBTAIN FLUXES; NOT CROSS SECTIONS           -
CD              2...MCNP, OBTAIN FLUXES AND CROSS SECTIONS            -
CD              3...DANTSYS, OBTAIN FLUXES AND CROSS SECTIONS         -
CN              ONLY DEFAULT OPTION AVAILABLE IN V 1.4                -
CD  4  19-24    0...(DEFAULT) SAVE STACK FILE IF DOING WRAPUP         -
CD              1...DO NOT SAVE STACK FILE                            -

C                                                                     -
C--------------------------------------------------------------------

CEOF
```

```
C******************************************************************
C                                                                -
C                        LAST REVISED 12/20/01                   -
C                                                                -
CF          A.SUMMAR                                             -
CE          SUMMARY BCD INPUT                                    -
C                                                                -
CN                      THIS BCD DATASET MAY BE WRITTEN EITHER   -
CN                      IN FREE FORMAT (UNFORM=A.SUMMAR) OR       -
CN                      ACCORDING TO THE FORMATS SPECIFIED FOR EACH -
CN                      CARD TYPE (DATASET=A.SUMMAR).            -
CN                                                               -
CN                      COLUMNS 1-2 MUST CONTAIN THE CARD TYPE NUMBER. -
C                                                                -
C******************************************************************


C----------------------------------------------------------------
CR          STORAGE AND OUTPUT EDITS (TYPE 01)                  -
C                                                                -
CL    FORMAT-----(I2,22X,5I6)                                    -
C                                                                -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY          -
CD  =  =======  =========================================================-
CD  1  1-2      01                                               -
CD                                                               -
CD  2  18-24    0...OUTPUT ON FT06F001 (DEFAULT)                 -
CD             10...OUTPUT ON FT10F001                           -
CD                                                               -
CD  3  25-30    POINTR DEBUGGING EDIT                            -
CD             0...NO DEBUGGING EDIT (DEFAULT)                   -
CD             1...DEBUGGING DUMP PRINTOUT                       -
CD             2...DEBUGGING TRACE PRINTOUT                      -
CD             3...FULL DEBUGGING PRINTOUT (TRACE AND DUMP)      -
CD                                                               -
CD  4  31-36    POINTR CONTAINER ARRAY SIZE IN REAL*8 WORDS      -
CD             (DEFAULT IS THE AVAILABLE CORE)                   -
CD                                                               -
CD  5  37-42    OUTPUT FLAG                                      -
CD             -1...MINIMUM OUTPUT EDITS                         -
CD             0...STANDARD OUTPUT EDITS (DEFAULT)               -
CD             1...DEBUGGING OUTPUT EDITS (MAXIMUM OUTPUT)       -
CD                                                               -
CD  6  43-48    PLOTTER FLAG (NOT USED IN REBUS-PC)              -
CD             0...PLOT FLUX AND POWER DENSITY (DEFAULT)         -
CD             1...DO NOT PRODUCE PLOT OUTPUT                    -
CD                                                               -
CD  7  49-54    ABNORMAL ERROR FLAG                              -
CD             0...DO NOT INVOKE ABEND FOR AN ABNORMAL ERROR (DEFAULT)-
CD             1...INVOKE ABEND FOR AN ABNORMAL ERROR            -
CD                                                               -
CD  8  55-60    EFFECTIVE ONE GROUP MICROSCOPIC CROSS SECTION EDIT -
CD             0...DO NOT INVOKE EDIT (DEFAULT)                  -
CD             1...INVOKE EDIT                                   -
C                                                                -
CN                      CARD TYPE 01 MUST BE PRESENT IN ORDER TO PLOT FLUX AND -
CN                      POWER DENSITY.                           -
C                                                                -
C----------------------------------------------------------------


C----------------------------------------------------------------
CR          PLOT SPECIFICATIONS (TYPE 02) (NOT USED IN REBUS-PC) -
C                                                                -
CL    FORMAT-----(I2,9X,A1,2I6)                                  -
C                                                                -
CD  #  COLUMNS          CONTENTS...IMPLICATIONS, IF ANY          -
CD  =  =======  =========================================================-
CD  1  1-2      02 (NOT USED IN REBUS-PC)                        -
CD                                                               -
CD  2  12       FLAG DIRECTION OF PLOT                           -
CD             X...PLOT IS IN THE DIRECTION OF THE X-AXIS (DEFAULT) -
```

```
CD               Y...PLOT IS IN THE DIRECTION OF THE Y-AXIS         -
CD                                                                  -
CD  3  13-18    THE NUMBER OF THE LINE IN THE ABOVE DIRECTION FOR   -
CD              WHICH DATA IS TO BE PLOTTED (DEFAULT=1)             -
CD                                                                  -
CD  4  19-24    THE NUMBER OF THE LEVEL IN THE Z-DIRECTION FOR WHICH -
CD              DATA IS TO BE PLOTTED (DEFAULT=1)                   -
C                                                                   -
C-------------------------------------------------------------------


C-------------------------------------------------------------------
CR           PLOT OPTIONS (TYPE 03) (NOT USED IN REBUS-PC)          -
C                                                                   -
CL    FORMAT-----(I2,4X,I6)                                         -
C                                                                   -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY            -
CD  =  =======  ========================================================-
CD  1  1-2      03                                                  -
CD                                                                  -
CD  2  7-12     SELECT PLOT                                         -
CD              0...PLOT GEOMETRY, FLUX, POWER DENSITY (DEFAULT)     -
CD              1...PLOT GEOMETRY, POWER DENSITY                    -
CD              2...PLOT GEOMETRY, FLUX                             -
CD              3...PLOT GEOMETRY                                   -
CD              4...PLOT POWER DENSITY, FLUX                        -
CD              5...PLOT POWER DENSITY                              -
CD              6...PLOT FLUX                                       -
C                                                                   -
C-------------------------------------------------------------------


C-------------------------------------------------------------------
CR           ISOTOPE CLASSIFICATION (TYPE 04)                       -
C                                                                   -
CL    FORMAT-----(I2,4X,I6,10A6)                                    -
C                                                                   -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY            -
CD  =  =======  ========================================================-
CD  1  1-2      04                                                  -
CD                                                                  -
CD  2  7-12     ISOTOPE CLASSIFICATION                              -
CD              1...FISSILE                                         -
CD              2...FERTILE                                         -
CD              3...OTHER ACTINIDE                                  -
CD              4...FISSION PRODUCT                                 -
CD              5...STRUCTURE                                       -
CD              6...COOLANT                                         -
CD              7...CONTROL                                         -
CD              8...UNDEFINED                                       -
CD              9...SPECIAL                                         -
CD                                                                  -
CD  3  13-18    ISOTXS ISOTOPE NAME IN THIS CLASSIFICATION          -
CD                                                                  -
CD  4  19-24    ISOTXS ISOTOPE NAME IN THIS CLASSIFICATION          -
CD                                                                  -
CD  5  25-30    ISOTXS ISOTOPE NAME IN THIS CLASSIFICATION          -
CD                                                                  -
CD  6  31-36    ISOTXS ISOTOPE NAME IN THIS CLASSIFICATION          -
CD                                                                  -
CD  7  37-42    ISOTXS ISOTOPE NAME IN THIS CLASSIFICATION          -
CD                                                                  -
CD  8  43-48    ISOTXS ISOTOPE NAME IN THIS CLASSIFICATION          -
CD                                                                  -
CD  9  49-54    ISOTXS ISOTOPE NAME IN THIS CLASSIFICATION          -
CD                                                                  -
CD 10  55-60    ISOTXS ISOTOPE NAME IN THIS CLASSIFICATION          -
CD                                                                  -
CD 11  61-66    ISOTXS ISOTOPE NAME IN THIS CLASSIFICATION          -
CD                                                                  -
CD 12  67-72    ISOTXS ISOTOPE NAME IN THIS CLASSIFICATION          -
C                                                                   -
```

```
CN                ANY VALUE IN COLS. 7-12 OTHER THAN 1-7 OR 9 WILL       -
CN                CORRESPOND TO A CLASSIFICATION OF UNDEFINED AND WILL    -
CN                BE INDICATED AS CLASSIFICATION 8 IN THE SUMMARY OUTPUT  -
CN                                                                        -
CN                IF NO TYPE 04 CARDS ARE SUPPLIED, THE CODE WILL         -
CN                DETERMINE THE ISOTOPE CLASSIFICATION OF EACH OF THE      -
CN                ISOTOPES IN THE PROBLEM BY COMPARING THE ENDF/B          -
CN                ABSOLUTE ISOTOPE NAMES WITH THE ISOTXS ISOTOPE NAMES.   -
CN                                                                        -
CN                THE TYPE 04 CARDS ARE USED TO CHANGE DEFAULT VALUES     -
CN                SET IN THE CODE.                                        -
C                                                                         -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR           MODIFY ISOTOPE SPECIFICATIONS (TYPE 05)                     -
C                                                                         -
CL     FORMAT-----(I2,4X,A6,A4,2X,F12.5,7A6)                             -
C                                                                         -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY                 -
CD  =  =======  =========================================================-
CD  1  1-2      05                                                       -
CD                                                                        -
CD  2  7-12     ENDF/B ABSOLUTE ISOTOPE NAME                             -
CD                                                                        -
CD  3  13-16    ALPHANUMERIC NUCLIDE TYPE I.D.                           -
CD              FISS...THE ISOTOPE NAMED IS TREATED AS FISSILE IN         -
CD                     CALCULATING BREEDING RATIOS                        -
CD              FERT...THE ISOTOPE NAMED IS TREATED AS FERTILE IN         -
CD                     CALCULATING BREEDING RATIOS                        -
CD              SPEC...THE ISOTOPE NAMED WILL NOT BE INCLUDED IN THE      -
CD                     CALCULATION OF BREEDING RATIOS, BUT FISSION AND    -
CD                     AND SOURCE REACTION RATES WILL BE CALCULATED       -
CD                                                                        -
CD  4  19-30    ATOMIC WEIGHT FOR THE ISOTOPE NAMED IN COLS. 7-12        -
CD                                                                        -
CD  5  31-36    ISOTXS ISOTOPE NAME FOR WHICH THESE DATA ARE TO BE       -
CD              USED                                                      -
CD  6  37-42    ISOTXS ISOTOPE NAME FOR WHICH THESE DATA ARE TO BE       -
CD              USED                                                      -
CD  7  43-48    ISOTXS ISOTOPE NAME FOR WHICH THESE DATA ARE TO BE       -
CD              USED                                                      -
CD  8  49-54    ISOTXS ISOTOPE NAME FOR WHICH THESE DATA ARE TO BE       -
CD              USED                                                      -
CD  9  55-60    ISOTXS ISOTOPE NAME FOR WHICH THESE DATA ARE TO BE       -
CD              USED                                                      -
CD 10  61-66    ISOTXS ISOTOPE NAME FOR WHICH THESE DATA ARE TO BE       -
CD              USED                                                      -
CD 11  67-72    ISOTXS ISOTOPE NAME FOR WHICH THESE DATA ARE TO BE       -
CD              USED                                                      -
C                                                                         -
CN              SEE COMMENTS FOLLOWING THE TYPE 06 CARD DESCRIPTION       -
C                                                                         -
C-----------------------------------------------------------------------

C-----------------------------------------------------------------------
CR           DEFINE ISOTOPE SPECIFICATIONS (TYPE 06)                     -
C                                                                         -
CL     FORMAT-----(I2,4X,A6,A4,2X,F12.5,7A6)                             -
C                                                                         -
CD  #  COLUMNS            CONTENTS...IMPLICATIONS, IF ANY                 -
CD  =  =======  =========================================================-
CD  1  1-2      06                                                       -
CD                                                                        -
CD  2  7-12     ENDF/B ABSOLUTE ISOTOPE NAME                             -
CD                                                                        -
CD  3  13-16    ALPHANUMERIC NUCLIDE TYPE I.D.                           -
CD              FISS...THE ISOTOPE NAMED IS TREATED AS FISSILE IN         -
CD                     CALCULATING BREEDING RATIOS                        -
CD              FERT...THE ISOTOPE NAMED IS TREATED AS FERTILE IN         -
```

```
CD                        CALCULATING BREEDING RATIOS              -
CD               SPEC...THE ISOTOPE NAMED WILL NOT BE INCLUDED IN THE   -
CD                        CALCULATION OF BREEDING RATIOS, BUT FISSION AND -
CD                        AND SOURCE REACTION RATES WILL BE CALCULATED  -
CD                                                                 -
CD   4   19-30   ATOMIC WEIGHT FOR THE ISOTOPE NAMED IN COLS. 7-12  -
CD                                                                 -
CD   5   31-36   ISOTXS ISOTOPE NAME FOR WHICH THESE DATA ARE TO BE -
CD               USED                                              -
CD   6   37-42   ISOTXS ISOTOPE NAME FOR WHICH THESE DATA ARE TO BE -
CD               USED                                              -
CD   7   43-48   ISOTXS ISOTOPE NAME FOR WHICH THESE DATA ARE TO BE -
CD               USED                                              -
CD   8   49-54   ISOTXS ISOTOPE NAME FOR WHICH THESE DATA ARE TO BE -
CD               USED                                              -
CD   9   55-60   ISOTXS ISOTOPE NAME FOR WHICH THESE DATA ARE TO BE -
CD               USED                                              -
CD  10   61-66   ISOTXS ISOTOPE NAME FOR WHICH THESE DATA ARE TO BE -
CD               USED                                              -
CD  11   67-72   ISOTXS ISOTOPE NAME FOR WHICH THESE DATA ARE TO BE -
CD               USED                                              -
C                                                                 -
CN               IF NO TYPE 05 OR TYPE 06 CARDS ARE SUPPLIED, THE CODE  -
CN               WILL DETERMINE THE ATOMIC WEIGHT AND TYPE OF EACH OF THE
CN               ISOTOPES IN THE PROBLEM BY COMPARING THE ENDF/B NAMES  -
CN               WITH THE ISOTXS ISOTOPE NAMES.                    -
CN                                                                 -
CN               THE TYPE 05 CARDS ARE USED TO CHANGE DEFAULT VALUES   -
CN               SET IN THE CODE.                                  -
CN                                                                 -
CN               IF TYPE 06 CARDS ARE SUPPLIED, ANY TYPE 05 CARD DATA  -
CN               WILL BE IGNORED AND ONLY ISOTOPES NAMED ON THE TYPE 06 -
CN               CARDS WILL BE INCLUDED IN THE REACTION SUMMARY.   -
C                                                                 -
C----------------------------------------------------------------------


C----------------------------------------------------------------------
CR           CORE REGION SPECIFICATION (TYPE 07)                   -
C                                                                 -
CL    FORMAT-----(I2,4X,11A6)                                      -
C                                                                 -
CD  #   COLUMNS          CONTENTS...IMPLICATIONS, IF ANY           -
CD  =   =======   =========================================================-
CD  1   1-2     07                                                 -
CD                                                                 -
CD  2   7-12    LABEL OF REGION CONSIDERED TO BE IN THE CORE BY THE   -
CD               REACTION SUMMARY                                  -
CD                                                                 -
CD  3   13-18   LABEL OF REGION CONSIDERED TO BE IN THE CORE BY THE   -
CD               REACTION SUMMARY                                  -
CD                                                                 -
CD  4   19-24   LABEL OF REGION CONSIDERED TO BE IN THE CORE BY THE   -
CD               REACTION SUMMARY                                  -
CD                                                                 -
CD  5   25-30   LABEL OF REGION CONSIDERED TO BE IN THE CORE BY THE   -
CD               REACTION SUMMARY                                  -
CD                                                                 -
CD  6   31-36   LABEL OF REGION CONSIDERED TO BE IN THE CORE BY THE   -
CD               REACTION SUMMARY                                  -
CD                                                                 -
CD  7   37-42   LABEL OF REGION CONSIDERED TO BE IN THE CORE BY THE   -
CD               REACTION SUMMARY                                  -
CD                                                                 -
CD  8   43-48   LABEL OF REGION CONSIDERED TO BE IN THE CORE BY THE   -
CD               REACTION SUMMARY                                  -
CD                                                                 -
CD  9   49-54   LABEL OF REGION CONSIDERED TO BE IN THE CORE BY THE   -
CD               REACTION SUMMARY                                  -
CD                                                                 -
CD  10  55-60   LABEL OF REGION CONSIDERED TO BE IN THE CORE BY THE   -
CD               REACTION SUMMARY                                  -
```

```
CD                                                                    -
CD  11  61-66   LABEL OF REGION CONSIDERED TO BE IN THE CORE BY THE    -
CD             REACTION SUMMARY                                        -
CD                                                                    -
CD  12  67-72   LABEL OF REGION CONSIDERED TO BE IN THE CORE BY THE    -
CD             REACTION SUMMARY                                        -
C                                                                    -
CN             IF NO TYPE 07 CARDS ARE SUPPLIED, THE CODE ASSUMES THAT-
CN             ALL REGIONS HAVING A TOTAL ATOM DENSITY OF ISOTOPES     -
CN             LABELED 'FISS' GREATER THAN 7.0E+20 ATOMS/CC ARE TO BE  -
CN             INCLUDED IN THE CORE.                                   -
C                                                                    -
C---------------------------------------------------------------------

CEOF
```

```
C******************************************************************-
C                                                                 -
C                    LATEST RERTR VERSION 12/21/01                -
C                                                                 -
CF          A.UDOIT                                               -
CE          INPUT FOR REBUS-PC SUMMARY REACTION RATE EDITS        -
C                                                                 -
CN                        THIS BCD DATA SET MAY BE WRITTEN         -
CN                        ACCORDING TO THE FORMATS SPECIFIED FOR EACH  -
CN                        CARD TYPE (DATASET=A.UDOIT).            -
CN                                                                -
CN                        COLUMNS 1-2 MUST CONTAIN THE CARD TYPE NUMBER. -
C                                                                 -
C******************************************************************-


C-----------------------------------------------------------------
CR          PROBLEM TITLE (TYPE 21)                               -
C                                                                 -
CL     FORMAT-----(I2,4X,11A6)                                    -
C                                                                 -
CD     COLUMNS           CONTENTS...IMPLICATIONS, IF ANY          -
CD     =======  ========================================================-
CD     1-2      21                                                -
CD                                                                -
CD     7-72     ANY ALPHANUMERIC CHARACTERS.                      -
CD                                                                -
CD              UP TO SIX TYPE 21 CARDS MAY BE USED.              -
C                                                                 -
C-----------------------------------------------------------------


C-----------------------------------------------------------------
CR          SECONDARY ISOTOPES LABELS (TYPE 22)                   -
C                                                                 -
CL     FORMAT-----(I2,4X,11A6)                                    -
C                                                                 -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY          -
CD  =  =======  ========================================================-
CD  1  1-2      22 (NOT USED IN REBUS-PC)                         -
CD                                                                -
CD  2  7-72     SECONDARY ISOTOPES LABELS.                        -
CD                                                                -
CN              THE LABEL PROVIDED ON THE TYPE 22 CARDS SHOULD    -
CN              CORRESPOND TO LABELS ON THE ISOTXS DATA SET.  THESE  -
CN              ISOTOPES WILL BE TREATED AS SECONDARY, AND WILL THUS  -
CN              HAVE NO EFFECT ON THE NEUTRONICS SOLUTION IN DIF3D  -
CN              (SAME TREATMENT AS IN GLASS).                     -
CN                                                                -
CN              AS MANY CARDS MAY BE USED AS NECESSARY TO SPECIFY ALL  -
CN              SECONDARY ISOTOPES.                               -
CN                                                                -
CN              IF NO SECONDARY ISOTOPES ARE SPECIFIED ON THE TYPE 22  -
CN              CARDS, THE BCD INTERFACE FILE SUMISO WILL NOT BE  -
CN              WRITTEN.                                          -
C                                                                 -
C-----------------------------------------------------------------


C-----------------------------------------------------------------
CR          REGION ISOTOPIC REACTION RATE EDIT SPECIFICATIONS (TYPE 25)-
C                                                                 -
CL     FORMAT-----(I2,4X,10A6)                                    -
C                                                                 -
CD  #  COLUMNS           CONTENTS...IMPLICATIONS, IF ANY          -
CD  =  =======  ========================================================-
CD  1  1-2      25                                                -
CD                                                                -
CD  2  7-66     ZONE (REGION) LABELS FOR WHICH ISOTOPIC REACTION RATE  -
CD              ARE TO BE EDITED.                                 -
CD                                                                -
CN              THE LABELS PROVIDED ON THE TYPE 25 CARDS ARE ACTUALLY  -
```

```
CN              INTERPRETED AS ZONE LABELS.  THE REBUS-PC        -
CN              INPUT PROCESSOR DEFINES EACH REGION AS A UNIQUE ZONE   -
CN              (EVEN THOUGH THEY MAY NOT BE DEFINED AS SUCH IN THE    -
CN              A.NIP3 DATASET), MAKING THE TWO EQUIVALENT.     -
CN                                                              -
CN              AS MANY CARDS MAY BE USED AS NECESSARY TO SPECIFY ALL  -
CN              REGIONS TO BE EDITED.                           -
CN                                                              -
CN              IF NO REGIONS ARE SPECIFIED ON THE TYPE 25 CARDS,     -
CN              NO BCD FILES WILL BE WRITTEN; OTHERWISE,        -
CN              THE FOLLOWING FILES ARE WRITTEN:                -
CN                SUMIRR.BCD                                    -
CN                SUMRRT.BCD                                    -
CN                UDOIT.BCD                                     -
CN                                                              -
CN              ++++++++++++++++++++++++++++++++++++++++++++++++++     -
CN              + CARD TYPES 1 THROUGH 20 HAVE BEEN RESERVED FOR +     -
CN              + APPLICATIONS IN OTHER UDOIT MODULES WHICH MAY  +     -
CN              + REQUIRE INPUT VIA THE A.UDOIT DATASET.        +      -
CN              ++++++++++++++++++++++++++++++++++++++++++++++++++     -
C                                                               -
C----------------------------------------------------------------------

CEOF
```

APPENDIX III: REVISED BINARY DATASETS FOR REBUS PC V 1.4 (USING VARIANT 9.0 OF DIF3D)

```
C*******************************************************************
C                                                                 -
C                        Latest Version 10/31/00                  -
C                        Current version 1.4 extracted 01/08/21   -
C                                                                 -
CF           NAFLUX                                               -
CE           ADJOINT NODAL FLUX-MOMENTS AND INTERFACE PARTIAL CURRENTS  -
C                                                                 -
CN                       ORDER OF GROUPS IS ACCORDING TO INCREASING  -
CN                       ENERGY FOR PHYSICAL ADJOINT, DECREASING ENERGY -
CN                       FOR MATHEMATICAL ADJOINT FLUXES.  NOTE THAT   -
CN                       DOUBLE PRECISION FLUXES ARE GIVEN WHEN MULT=2. -
C                                                                 -
CN                       THIS FILE DESCRIPTION IS FOR DIF3D/VARIANT 9.0 -
C                                                                 -
C*******************************************************************
C-----------------------------------------------------------------
CS           FILE STRUCTURE                                       -
CS                                                                -
CS           RECORD TYPE                     RECORD    PRESENT IF  -
CS           ========================        ======    ==========  -
CS           FILE IDENTIFICATION                       ALWAYS      -
CS           SPECIFICATIONS                  1D        ALWAYS      -
CS           INTEGER POINTERS                2D        NSURF.GT.1  -
CS                                                                -
CD    NODAL METHOD - DIF3D OPTION                                 -
CD    ==========================                                 -
CS **********(REPEAT FOR ALL GROUPS) - PHYSICAL ADJOINT          -
CS *         FLUX MOMENTS                    3D        ALWAYS      -
CS *         XY-DIRECTED PARTIAL CURRENTS    4D        ALWAYS      -
CS *         Z -DIRECTED PARTIAL CURRENTS    5D        NDIM.EQ.3   -
CS **********                                                     -
CS                                                                -
CS **********(REPEAT FOR ALL GROUPS) - MATHEMATICAL ADJOINT(ITRORD=0)-
CS *         FLUX MOMENTS                    3D        ALWAYS      -
CS *         XY-DIRECTED PARTIAL CURRENTS    4D        ALWAYS      -
CS *         Z -DIRECTED PARTIAL CURRENTS    5D        NDIM.EQ.3   -
CS **********                                                     -
CD    ==========================                                 -
C                                                                 -
CD    NODAL METHOD - VARIANT OPTION                              -
CD    ==========================                                 -
CS **********(REPEAT FOR ALL GROUPS)                             -
CS *         FLUX MOMENTS                    3D        IWNHFL=0 OR 1 -
CS *         XY-DIRECTED PARTIAL CURRENTS    4D        IWNHFL=0 OR 2 -
CS *         Z -DIRECTED PARTIAL CURRENTS    5D        NDIM.EQ.3 AND -
CS *                                                   IWNHFL=0 OR 2 -
CS **********                                                     -
CD    ==========================                                 -
C                                                                 -
C                                                                 -
CN           MATHEMATICAL ADJOINT FOR DIF3D NODAL, BUT NOT VARIANT  -
C-----------------------------------------------------------------
C-----------------------------------------------------------------
CR           FILE IDENTIFICATION                                  -
C                                                                 -
CL    HNAME,(HUSE(I),I=1,2),IVERS                                 -
C                                                                 -
CW    1+3*MULT=NUMBER OF WORDS                                    -
C                                                                 -
CD    HNAME             HOLLERITH FILE NAME - NAFLUX - (A6)       -
CD    HUSE(I)           HOLLERITH USER IDENTIFICATION (A6)        -
CD    IVERS             FILE VERSION NUMBER                       -
CD    MULT              DOUBLE PRECISION PARAMETER                -
CD                           1- A6 WORD IS SINGLE WORD            -
CD                           2- A6 WORD IS DOUBLE PRECISION WORD  -
C                                                                 -
```

```
C------------------------------------------------------------------------
CD      ============================================================ -
CD      NODAL METHOD - DIF3D 9.0 OPTION                              -
CD      ============================================================ -
C------------------------------------------------------------------------
CR           SPECIFICATIONS    (1D RECORD)                           -
C                                                                    -
CL      NDIM,NGROUP,NINTI,NINTJ,NINTK,ITER,EFFK,POWER,NSURF,         -
CL      NMOM,NINTXY,NPCXY,NSCOEF,ITRORD,IAPRX,ILEAK,IAPRXZ,ILEAKZ,   -
CL      IORDER,IDUM                                                  -
C                                                                    -
CW      20 =NUMBER OF WORDS                                          -
C                                                                    -
CD      NDIM            NUMBER OF DIMENSIONS                         -
CD      NGROUP          NUMBER OF ENERGY GROUPS                      -
CD      NINTI           NUMBER OF FIRST DIMENSION FINE MESH INTERVALS -
CD      NINTJ           NUMBER OF SECOND DIMENSION FINE MESH INTERVALS -
CD      NINTK           NUMBER OF THIRD DIMENSION FINE MESH INTERVALS. -
CD                      NINTK.EQ.1 IF NDIM.LE.2                      -
CD      ITER            OUTER ITERATION NUMBER AT WHICH FLUX WAS     -
CD                      WRITTEN                                      -
CD      EFFK            EFFECTIVE MULTIPLICATION FACTOR              -
CD      POWER           POWER IN WATTS TO WHICH FLUX IS NORMALIZED   -
CD      NSURF           NUMBER OF XY-PLANE SURFACES PER NODE.        -
CD      NMOM            NUMBER OF FLUX MOMENTS IN NODAL APPROXIMATION -
CD      NINTXY          NUMBER OF MESH CELLS (NODES) ON XY-PLANE     -
CD      NPCXY           NUMBER OF XY-DIRECTED PARTIAL CURRENTS ON    -
CD                      XY-PLANE                                     -
CD                                                                   -
CD                                                                   -
CD      NSCOEF          NUMBER OF UNKNOWNS PER NODE SURFACE,         -
CD                      =1, NODAL DIFFUSION THEORY                   -
CD                      =2, NODAL TRANSPORT THEORY, ISOTROPIC        -
CD                          TRANSVERSE LEAKAGE                       -
CD                      =3, NODAL TRANSPORT THEORY, P1              -
CD                          TRANSVERSE LEAKAGE                       -
CD      ITRORD          ORDER OF NODAL TRANSPORT CALCULATION         -
CD                      =0, NODAL DIFFUSION THEORY                   -
CD                      =1, NODAL TRANSPORT THEORY, ISOTROPIC        -
CD                          TRANSVERSE LEAKAGE                       -
CD                      =2, NODAL TRANSPORT THEORY, P1              -
CD                          TRANSVERSE LEAKAGE                       -
CD      IAPRX           ORDER OF FLUX APPROXIMATION IN XY PLANE      -
CD                                                                   -
CD                      HEXAGONAL GEOMETRY:                          -
CD                      =2, NH2 FLUX APPROXIMATION                   -
CD                      =3, NH3 FLUX APPROXIMATION                   -
CD                      =4, NH4 FLUX APPROXIMATION                   -
CD                                                                   -
CD                      CARTESIAN GEOMETRY:                          -
CD                      =2, NX2 (QUADRATIC) FLUX APPROXIMATION       -
CD                      =3, NX3 (CUBIC) FLUX APPROXIMATION           -
CD                      =4, NX4 (QUARTIC) FLUX APPROXIMATION         -
CD      ILEAK           XY-PLANE LEAKAGE APPROXIMATION               -
CD                      =0, CONSTANT LEAKAGE APPROXIMATION           -
CD                      =2, QUADRATIC LEAKAGE APPROXIMATION          -
CD      IAPRXZ          ORDER OF FLUX APPROXIMATION IN AXIAL DIRECTION -
CD                      =2, NZ2 (QUADRATIC) FLUX APPROXIMATION       -
CD                      =3, NZ3 (CUBIC) FLUX APPROXIMATION           -
CD                      =4, NZ4 (QUARTIC) FLUX APPROXIMATION         -
CD      ILEAKZ          AXIAL LEAKAGE APPROXIMATION                  -
CD                      =0, CONSTANT LEAKAGE APPROXIMATION           -
CD                      =2, QUADRATIC LEAKAGE APPROXIMATION          -
CD      IORDER          MESH ORDERING SENTINEL                       -
CD                      =0, ORIGINAL NODAL ORDERING PRIOR TO DIF3D 7.0 -
CD                      =1, REVISED NODAL ORDERING, DIF3D 7.0        -
CN                      IORDER PERMITS DETECTION OF NAFLUX FILES FROM -
CN                      DIF3D VERSIONS PRECEDING DIF3D 7.0           -
C                                                                    -
C                                                                    -
C------------------------------------------------------------------------
C------------------------------------------------------------------------
```

```
CR          INTEGER POINTERS   (2D RECORD)                          -
C                                                                   -
CC          PRESENT IF NSURF.GT.1                                   -
C                                                                   -
CL    (IPCPNT(I,J),I=1,NSURF),J=1,NINTXY),(IPCBDY(I),I=1,NPCBDY),   -
CL    (ITRMAP(I),I=1,NINTXY)                                        -
C                                                                   -
CW    NSURF*NINTXY + NPCBDY + NINTXY =NUMBER OF WORDS               -
C                                                                   -
CD    IPCPNT(I,J)         POINTERS TO OUTGOING XY-PLANE PARTIAL CURRENTS.-
CD    IPCBDY(I)           POINTERS TO INCOMING PARTIAL CURRENTS ON OUTER -
CD                        XY-PLANE BOUNDARY.                         -
CD    ITRMAP(I)           TRANSFORMATION MAP BETWEEN NODAL AND GEODST -
CD                        MESH CELL ORDERINGS.                       -
CD    NPCBDY              = NPCXY - NSURF*NINTXY.                    -
C                                                                   -
C                                                                   -
CN                        IPCBDY WILL INCLUDE INCOMING PARTIAL CURRENTS  -
CN                        ON CERTAIN SYMMETRY BOUNDARIES TO AVOID VECTOR -
CN                        RECURSION IN DIF3D 7.0 AND LATER VERSIONS. -
C                                                                   -
CN                        THE NODAL ORDERING IN DIF3D 7.0 AND LATER -
CN                        VERSIONS HAS ACTIVE NODES ORDERED BY COLOR, -
CN                        FOLLOWED BY INACTIVE NODES.                -
C                                                                   -
CN                        NOTICE THE REVERSED ORIENTATION OF OUTGOING AND-
CN                        INCOMING PARTIAL CURRENTS FOR NHFLUX VS. NAFLUX-
C-------------------------------------------------------------------
C-------------------------------------------------------------------
CR          ADJOINT FLUX MOMENTS   (3D RECORD)                      -
C                                                                   -
CL    ((FLUX(I,J),I=1,NMOM),J=1,NINTXY)------SEE STRUCTURE BELOW----- -
C                                                                   -
CW    NMOM*NINTXY*MULT = NUMBER OF WORDS                            -
C                                                                   -
C     DO 1 K=1,NINTK                                                -
C  1 READ(N)   *LIST AS ABOVE*                                      -
C                                                                   -
CD    FLUX(I,J)           ADJOINT FLUX MOMENTS BY NODE FOR THE PRESENT -
CD                        GROUP                                     -
C                                                                   -
C-------------------------------------------------------------------
C-------------------------------------------------------------------
CR          ADJOINT XY-DIRECTED PARTIAL CURRENTS   (4D RECORD)      -
C                                                                   -
CD                                                                  -
CD                                                                  -
CL    ((PCURRH(I,M),I=1,NPCXY),M=1,NSCOEF) ----SEE STRUCTURE BELOW---- -
C                                                                   -
CW    NPCXY*NSCOEF*MULT = NUMBER OF WORDS                           -
C                                                                   -
C     DO 1 K=1,NINTK                                                -
C  1 READ(N)   *LIST AS ABOVE*                                      -
C                                                                   -
CD    PCURRH(I,M)         INCOMING XY-DIRECTED PARTIAL CURRENTS (M=1) AND-
CD                        HALF-ANGLE INTEGRATED FLUXES (M=2) ACROSS ALL  -
CD                        XY-PLANE SURFACES FOR THE PRESENT GROUP   -
CD                                                                  -
CD                                                                  -
C                                                                   -
CN    ELEMENTS I=1,NSURF*NINTXY OF EACH VECTOR PCURRH(.,M) MAP TO   -
CN    SURFACE S OF NODE N WHERE  S = MOD(I-1,NSURF)+1  AND          -
CN    N = (I-1)/NSURF + 1                                           -
CN                                                                  -
CN    THE REMAINING ELEMENTS (PCURRH(I,M),I=NSURF*NINTXY+1,NPCXY),  -
CN    IF ANY, CORRESPOND TO OUTGOING PARTIAL CURRENTS (M=1) OR OUTGOING-
CN    HALF-ANGLE INTEGRATED FLUXES (M=2) FOR NODE SURFACES ON THE OUTER-
CN    (POSSIBLY IRREGULAR) XY-PLANE BOUNDARY.                       -
CN                                                                  -
CN    THE FOLLOWING ORIENTATION IS USED TO DENOTE                   -
CN    SURFACES J=1,...,NSURF AND NEIGHBORING NODES J=1,...,NSURF:   -
CN                                                                  -
```

```
CN                   *                                          Y              -
CN         J=3  *    * J=2                                      ^              -
CN            *        *                          J=2          |              -
CN          *            *                     *******          |              -
CN          *            *                     *      *         |              -
CN    J=4  *              *  J=1        J=3  *       * J=1   +----> X          -
CN          *            *                     *      *                        -
CN           *          *                      *******                         -
CN         J=5  *    * J=6                          J=4                         -
CN                 *                                                           -
CN                                                                            -
CN       HEXAGONAL NODES                   CARTESIAN NODES                     -
CN          NSURF = 6                         NSURF = 4                        -
C                                                                             -
C----------------------------------------------------------------------------
C----------------------------------------------------------------------------
CR           ADJOINT  Z-DIRECTED PARTIAL CURRENTS    (5D RECORD)        -
C                                                                             -
CL    (((PCURRZ(I,M,J),I=1,NINTXY),M=1,NSCOEF),J=1,2)                   -
CL                                    ------SEE STRUCTURE BELOW---------
C                                                                             -
CW    NINTXY*NSCOEF*2*MULT = NUMBER OF WORDS                           -
C                                                                             -
C     DO 1 K=1,NINTK1                                                  -
C   1 READ(N)   *LIST AS ABOVE*                                       -
C                                                                             -
CC          WITH NINTK1 = NINTK + 1                                   -
C                                                                             -
CD    PCURRZ(I,M,J)      ADJOINT Z-DIRECTED PARTIAL CURRENTS (M=1) AND  -
CD                       HALF-ANGLE INTEGRATED FLUXES (M=2) IN          -
CD                       MINUS- (J=1) AND PLUS- (J=2) Z DIRECTIONS      -
CD                       ACROSS ALL AXIAL BOUNDARIES FOR THE PRESENT    -
CD                       GROUP                                          -
C                                                                             -
CN                       E.G. OUTGOING PARTIAL CURRENTS FOR NODE I ON   -
CN                       AXIAL MESH INTERVAL K ARE PCURRZ(I,1,1) ON THE -
CN                       LOWER BOUNDARY (RECORD K) AND PCURRZ(I,1,2) ON -
CN                       THE UPPER AXIAL BOUNDARY (RECORD K+1).         -
C                                                                             -
C                                                                             -
C----------------------------------------------------------------------------
CD    ===========================================================  -
CD    NODAL METHOD - VARIANT 9.0 OPTION                            -
CD    ===========================================================  -
C----------------------------------------------------------------------------
CR           SPECIFICATIONS      (1D RECORD)                           -
C                                                                             -
CL    NDIM,NGROUP,NINTI,NINTJ,NINTK,ITER,EFFK,POWER,NSURF,            -
CL    NMOM,NINTXY,NPCXY,NSCOEF,ITRORD,IAPRX,ILEAK,IAPRXZ,ILEAKZ,      -
CL    IORDER,NPCBDY,NPCSYM,NPCSEC,IWNHFL,(IDUM,I=1,7)                 -
C                                                                             -
CW    30 =NUMBER OF WORDS                                            -
C                                                                             -
CD    NDIM               NUMBER OF DIMENSIONS                         -
CD    NGROUP             NUMBER OF ENERGY GROUPS                      -
CD    NINTI              NUMBER OF FIRST DIMENSION FINE MESH INTERVALS -
CD    NINTJ              NUMBER OF SECOND DIMENSION FINE MESH INTERVALS -
CD    NINTK              NUMBER OF THIRD DIMENSION FINE MESH INTERVALS. -
CD                       NINTK.EQ.1 IF NDIM.LE.2                      -
CD    ITER               OUTER ITERATION NUMBER AT WHICH FLUX WAS     -
CD                       WRITTEN                                      -
CD    EFFK               EFFECTIVE MULTIPLICATION FACTOR              -
CD    POWER              POWER IN WATTS TO WHICH FLUX IS NORMALIZED   -
CD    NSURF              NUMBER OF XY-PLANE SURFACES PER NODE.        -
CD    NMOM               NUMBER OF FLUX MOMENTS IN NODAL APPROXIMATION -
CD    NINTXY             NUMBER OF MESH CELLS (NODES) ON XY-PLANE     -
CD    NPCXY              NUMBER OF XY-DIRECTED PARTIAL CURRENTS ON     -
CD                       XY-PLANE                                     -
CD    NSCOEF             NUMBER OF PARTIAL CURRENT MOMENTS PER NODE    -
CD                       SURFACE                                      -
CD    ITRORD             ORDER OF THE POLYNOMIAL APPROXIMATION OF THE  -
CD                       SOURCE WITHIN THE NODE                       -
```

```
CD    IAPRX              ORDER OF THE POLYNOMIAL APPROXIMATION OF THE   -
CD                       FLUXES WITHIN THE NODE                         -
CD    ILEAK              ORDER OF THE POLYNOMIAL APPROXIMATION OF THE   -
CD                       LEAKAGES ON THE SURFACES OF THE NODES          -
CD    IAPRXZ             ORDER OF THE PN EXPANSION OF THE FLUX          -
CD    ILEAKZ             ORDER OF THE PN EXPANSION OF THE LEAKAGE       -
CD    IORDER             DIF3D VERSION                                 -
CD                       =0, VERSION 8.0 OR PREVIOUS ONES               -
CD                       =2, VERSION 9.0                                -
CD    NPCBDY             NUMBER OF INCOMING PARTIAL CURRENTS ON OUTER   -
CD                       XY-PLANE BOUNDARY.                             -
CD    NPCSYM             NUMBER OF OUTGOING PARTIAL CURRENTS ON         -
CD                       SYMMETRIC XY-PLANE BOUNDARY. HEXAGONAL         -
CD                       GEOMETRY ONLY.                                 -
CD    NPCSEC             NUMBER OF OUTGOING PARTIAL CURRENTS ON         -
CD                       SECTOR XY-PLANE BOUNDARY. HEXAGONAL GEOMETRY   -
CD                       ONLY.                                          -
CD    IWNHFL             NHFLUX CONTENT                                -
CD                       =0, BOTH FLUXES AND PARTIAL CUURENTS ARE       -
CD                           PRESENT IN THE FILE                        -
CD                       =1, ONLY FLUXES ARE PRESENT                    -
CD                       =2, ONLY PARTIAL CURRENTS ARE PRESENT          -
CD    IDUM               RESERVED FOR FUTURE USE                        -
C                                                                       -
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
CR             INTEGER POINTERS   (2D RECORD)                           -
C                                                                       -
CC             PRESENT IF NSURF.GT.1                                    -
C                                                                       -
CL    (IPCPNT(I,J),I=1,NSURF),J=1,NINTXY),(IPCBDY(I),I=1,NPCBDY),      -
CL    (ITRMAP(I),I=1,NINTXY),(IPCSYM(I),I=1,NPCSTO),                   -
CL    (IPCSCP(I),I=1,NPCSTO)                                           -
C                                                                       -
CW    NSURF*NINTXY + NPCBDY + NINTXY + 2*NPCSTO =NUMBER OF WORDS       -
C                                                                       -
CD    IPCPNT(I,J)        POINTERS TO OUTGOING XY-PLANE PARTIAL CURRENTS.-
CD    IPCBDY(I)          POINTERS TO INCOMING PARTIAL CURRENTS ON OUTER -
CD                       XY-PLANE BOUNDARY.                             -
CD    ITRMAP(I)          TRANSFORMATION MAP BETWEEN NODAL AND GEODST    -
CD                       MESH CELL ORDERINGS.                           -
CD    IPCSYM(I)          POINTERS TO OUTGOING PARTIAL CURRENTS ON       -
CD                       SYMMETRIC AND SECTOR XY-PLANE BOUNDARY.        -
CD                       HEXAGONAL GEOMETRY ONLY.                       -
CD    IPCSTO(I)          POINTERS TO INGOING PARTIAL CURRENTS ON        -
CD                       SYMMETRIC AND SECTOR XY-PLANE BOUNDARY.        -
CD                       HEXAGONAL GEOMETRY ONLY.                       -
CD    NPCSTO             = NPCSYM + NPCSEC                              -
CD    NPCXY              = NSURF*NINTXY + NPCBDY + NPCSTO               -
C                                                                       -
C                                                                       -
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
CR             ADJOINT FLUX MOMENTS   (3D RECORD)                       -
C                                                                       -
CL    ((FLUX(I,J),I=1,NMOM),J=1,NINTXY)------SEE STRUCTURE BELOW-----   -
C                                                                       -
CW    NMOM*NINTXY*MULT = NUMBER OF WORDS                               -
C                                                                       -
C     DO 1 K=1,NINTK                                                   -
C   1 READ(N)   *LIST AS ABOVE*                                        -
C                                                                       -
CD    FLUX(I,J)          ADJOINT FLUX MOMENTS BY NODE FOR THE PRESENT   -
CD                       GROUP                                          -
C                                                                       -
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
CR             ADJOINT XY-DIRECTED PARTIAL CURRENTS   (4D RECORD)       -
C                                                                       -
CD                                                                      -
CL    ((PCURRH(M,I),M=1,NSCOEF),I=1,NPCXY) ----SEE STRUCTURE BELOW---- -
C                                                                       -
```

```
CW     NPCXY*NSCOEF*MULT = NUMBER OF WORDS                              -
C                                                                       -
C      DO 1 K=1,NINTK                                                   -
C    1 READ(N)   *LIST AS ABOVE*                                        -
C                                                                       -
CD     PCURRH(M,I)       INCOMING XY-DIRECTED PARTIAL CURRENTS          -
CD                       ACROSS ALL XY-PLANE SURFACES FOR THE           -
CD                       THE PRESENT GROUP                              -
CD     ========================================================== -
C                                                                       -
CN     ELEMENTS I=1,NSURF*NINTXY OF EACH VECTOR PCURRH(M,.) MAP TO      -
CN     SURFACE S OF NODE N WHERE  S = MOD(I-1,NSURF)+1   AND            -
CN     N = (I-1)/NSURF + 1. M INDEX OF PARTIAL CURRENT MOMENT.          -
CN                                                                      -
CN     THE REMAINING ELEMENTS (PCURRH(M,I),I=NSURF*NINTXY+1,NPCXY),     -
CN     IF ANY, CORRESPOND TO OUTGOING PARTIAL CURRENTS ON THE OUTER     -
CN     (POSSIBLY IRREGULAR) XY-PLANE BOUNDARY.                          -
CN                                                                      -
CN     THE FOLLOWING ORIENTATION IS USED TO DENOTE                     -
CN     SURFACES J=1,...,NSURF AND NEIGHBORING NODES J=1,...,NSURF:      -
CN                                                                      -
CN              *                                      Y               -
CN         J=3 *    * J=2                              ^               -
CN           *        *                         J=2    |               -
CN          *          *                      ******    |               -
CN          *          *                      *    *    |               -
CN     J=4 *            * J=1        J=3 *        * J=1   +----> X       -
CN          *          *                      *    *                    -
CN           *        *                       ******                    -
CN         J=5 *    * J=6                        J=4                     -
CN              *                                                       -
CN                                                                      -
CN      HEXAGONAL NODES                   CARTESIAN NODES               -
CN         NSURF = 6                         NSURF = 4                  -
C                                                                       -
C----------------------------------------------------------------------
C----------------------------------------------------------------------
CR          ADJOINT  Z-DIRECTED PARTIAL CURRENTS   (5D RECORD)          -
C                                                                       -
CL     (((PCURRZ(M,I,J),M=1,NSCOEF),I=1,NINTXY),J=1,2)                  -
CL                                    ------SEE STRUCTURE BELOW--------
C                                                                       -
CW     NINTXY*NSCOEF*2*MULT = NUMBER OF WORDS                           -
C                                                                       -
C      DO 1 K=1,NINTK1                                                  -
C    1 READ(N)   *LIST AS ABOVE*                                        -
C                                                                       -
CC          WITH NINTK1 = NINTK + 1                                     -
C                                                                       -
CD     PCURRZ(M,I,J)     Z-DIRECTED PARTIAL CURRENTS IN                 -
CD                       MINUS- (J=1) AND PLUS- (J=2) Z DIRECTIONS      -
CD                       ACROSS ALL AXIAL BOUNDARIES FOR THE PRESENT    -
CD                       GROUP                                          -
C                                                                       -
CN                       E.G. OUTGOING PARTIAL CURRENTS FOR NODE I ON   -
CN                       AXIAL MESH INTERVAL K ARE PCURRZ(1,I,1) ON THE -
CN                       LOWER BOUNDARY (RECORD K) AND PCURRZ(1,I,2) ON -
CN                       THE UPPER AXIAL BOUNDARY (RECORD K+1).         -
C----------------------------------------------------------------------
CEOF
```

```
C*********************************************************************
C                                                                    -
C                        Latest Version 10/31/00                     -
C                        Current version 1.4 extracted 01/08/21       -
C                                                                    -
CF          NHFLUX                                                   -
CE          REGULAR NODAL FLUX-MOMENTS AND INTERFACE PARTIAL CURRENTS -
C                                                                    -
CN                        ORDER OF GROUPS IS ACCORDING TO DECREASING  -
CN                        ENERGY. NOTE THAT DOUBLE PRECISION FLUXES ARE -
CN                        GIVEN WHEN MULT=2                           -
C                                                                    -
CN                        THIS FILE DESCRIPTION IS FOR DIF3D/VARIANT 9.0 -
C                                                                    -
C*********************************************************************
C---------------------------------------------------------------------
CS          FILE STRUCTURE                                           -
CS                                                                   -
CS          RECORD TYPE                       RECORD    PRESENT IF    -
CS          =========================         ======    ==========    -
CS          FILE IDENTIFICATION                         ALWAYS        -
CS          SPECIFICATIONS                    1D        ALWAYS        -
CS          INTEGER POINTERS                  2D        NSURF.GT.1    -
CS                                                                   -
CD    NODAL METHOD - DIF3D OPTION                                    -
CD    ===========================                                    -
CS **********(REPEAT FOR ALL GROUPS)                                 -
CS *       FLUX MOMENTS                       3D        ALWAYS        -
CS *       XY-DIRECTED PARTIAL CURRENTS       4D        ALWAYS        -
CS *       Z -DIRECTED PARTIAL CURRENTS       5D        NDIM.EQ.3     -
CS **********                                                        -
CD    ===========================                                    -
C                                                                    -
C                                                                    -
CD    NODAL METHOD - VARIANT OPTION                                  -
CD    ===========================                                    -
CS **********(REPEAT FOR ALL GROUPS)                                 -
CS *       FLUX MOMENTS                       3D        IWNHFL=0 OR 1  -
CS *       XY-DIRECTED PARTIAL CURRENTS       4D        IWNHFL=0 OR 2  -
CS *       Z -DIRECTED PARTIAL CURRENTS       5D        NDIM.EQ.3 AND  -
CS *                                                    IWNHFL=0 OR 2  -
CS **********                                                        -
CD    ===========================                                    -
C                                                                    -
C                                                                    -
C---------------------------------------------------------------------
C---------------------------------------------------------------------
CR          FILE IDENTIFICATION                                      -
C                                                                    -
CL    HNAME,(HUSE(I),I=1,2),IVERS                                    -
C                                                                    -
CW    1+3*MULT=NUMBER OF WORDS                                       -
C                                                                    -
CD    HNAME              HOLLERITH FILE NAME - NHFLUX - (A6)          -
CD    HUSE(I)            HOLLERITH USER IDENTIFICATION (A6)           -
CD    IVERS              FILE VERSION NUMBER                          -
CD    MULT               DOUBLE PRECISION PARAMETER                   -
CD                          1- A6 WORD IS SINGLE WORD                 -
CD                          2- A6 WORD IS DOUBLE PRECISION WORD       -
C                                                                    -
C---------------------------------------------------------------------
CD    ============================================================== -
CD    NODAL METHOD - DIF3D 9.0 OPTION                                -
CD    ============================================================== -
C---------------------------------------------------------------------
CR          SPECIFICATIONS     (1D RECORD)                           -
C                                                                    -
CL    NDIM,NGROUP,NINTI,NINTJ,NINTK,ITER,EFFK,POWER,NSURF,           -
CL    NMOM,NINTXY,NPCXY,NSCOEF,ITRORD,IAPRX,ILEAK,IAPRXZ,ILEAKZ,     -
CL    IORDER,IDUM                                                    -
C                                                                    -
CW    20 =NUMBER OF WORDS                                           -
```

```
C                                                                        -
CD    NDIM              NUMBER OF DIMENSIONS                             -
CD    NGROUP            NUMBER OF ENERGY GROUPS                          -
CD    NINTI             NUMBER OF FIRST DIMENSION FINE MESH INTERVALS    -
CD    NINTJ             NUMBER OF SECOND DIMENSION FINE MESH INTERVALS   -
CD    NINTK             NUMBER OF THIRD DIMENSION FINE MESH INTERVALS.   -
CD                      NINTK.EQ.1 IF NDIM.LE.2                          -
CD    ITER              OUTER ITERATION NUMBER AT WHICH FLUX WAS         -
CD                      WRITTEN                                          -
CD    EFFK              EFFECTIVE MULTIPLICATION FACTOR                  -
CD    POWER             POWER IN WATTS TO WHICH FLUX IS NORMALIZED       -
CD    NSURF             NUMBER OF XY-PLANE SURFACES PER NODE.            -
CD    NMOM              NUMBER OF FLUX MOMENTS IN NODAL APPROXIMATION    -
CD    NINTXY            NUMBER OF MESH CELLS (NODES) ON XY-PLANE         -
CD    NPCXY             NUMBER OF XY-DIRECTED PARTIAL CURRENTS ON        -
CD                      XY-PLANE                                         -
CD                                                                      -
CD                                                                      -
CD    NSCOEF            NUMBER OF UNKNOWNS PER NODE SURFACE,             -
CD                      =1, NODAL DIFFUSION THEORY                       -
CD                      =2, NODAL TRANSPORT THEORY, ISOTROPIC            -
CD                          TRANSVERSE LEAKAGE                           -
CD                      =3, NODAL TRANSPORT THEORY, P1                   -
CD                          TRANSVERSE LEAKAGE                           -
CD    ITRORD            ORDER OF NODAL TRANSPORT CALCULATION             -
CD                      =0, NODAL DIFFUSION THEORY                       -
CD                      =1, NODAL TRANSPORT THEORY, ISOTROPIC            -
CD                          TRANSVERSE LEAKAGE                           -
CD                      =2, NODAL TRANSPORT THEORY, P1                   -
CD                          TRANSVERSE LEAKAGE                           -
CD    IAPRX             ORDER OF FLUX APPROXIMATION IN XY PLANE          -
CD                                                                      -
CD                      HEXAGONAL GEOMETRY:                              -
CD                      =2, NH2 FLUX APPROXIMATION                       -
CD                      =3, NH3 FLUX APPROXIMATION                       -
CD                      =4, NH4 FLUX APPROXIMATION                       -
CD                                                                      -
CD                      CARTESIAN GEOMETRY:                              -
CD                      =2, NX2 (QUADRATIC) FLUX APPROXIMATION           -
CD                      =3, NX3 (CUBIC) FLUX APPROXIMATION               -
CD                      =4, NX4 (QUARTIC) FLUX APPROXIMATION             -
CD    ILEAK             XY-PLANE LEAKAGE APPROXIMATION                   -
CD                      =0, CONSTANT LEAKAGE APPROXIMATION               -
CD                      =2, QUADRATIC LEAKAGE APPROXIMATION              -
CD    IAPRXZ            ORDER OF FLUX APPROXIMATION IN AXIAL DIRECTION   -
CD                      =2, NZ2 (QUADRATIC) FLUX APPROXIMATION           -
CD                      =3, NZ3 (CUBIC) FLUX APPROXIMATION               -
CD                      =4, NZ4 (QUARTIC) FLUX APPROXIMATION             -
CD    ILEAKZ            AXIAL LEAKAGE APPROXIMATION                      -
CD                      =0, CONSTANT LEAKAGE APPROXIMATION               -
CD                      =2, QUADRATIC LEAKAGE APPROXIMATION              -
CD    IORDER             MESH ORDERING SENTINEL                         -
CD                      =0, ORIGINAL NODAL ORDERING PRIOR TO DIF3D 7.0  -
CD                      =1, REVISED NODAL ORDERING, DIF3D 7.0           -
CN                      IORDER PERMITS DETECTION OF NHFLUX FILES FROM    -
CN                      DIF3D VERSIONS PRECEDING DIF3D 7.0              -
C                                                                        -
C                                                                        -
C------------------------------------------------------------------------
C------------------------------------------------------------------------
CR         INTEGER POINTERS    (2D RECORD)                              -
C                                                                        -
CC         PRESENT IF NSURF.GT.1                                        -
C                                                                        -
CL    (IPCPNT(I,J),I=1,NSURF),J=1,NINTXY),(IPCBDY(I),I=1,NPCBDY),       -
CL    (ITRMAP(I),I=1,NINTXY)                                            -
C                                                                        -
CW    NSURF*NINTXY + NPCBDY + NINTXY =NUMBER OF WORDS                   -
C                                                                        -
CD    IPCPNT(I,J)       POINTERS TO INCOMING XY-PLANE PARTIAL CURRENTS.-
CD    IPCBDY(I)         POINTERS TO OUTGOING PARTIAL CURRENTS ON OUTER -
CD                      XY-PLANE BOUNDARY.                               -
```

131

```
CD    ITRMAP(I)          TRANSFORMATION MAP BETWEEN NODAL AND GEODST   -
CD                       MESH CELL ORDERINGS.                          -
CD    NPCBDY             = NPCXY - NSURF*NINTXY.                       -
C                                                                      -
C                                                                      -
CN                       IPCBDY WILL INCLUDE OUTGOING PARTIAL CURRENTS -
CN                       ON CERTAIN SYMMETRY BOUNDARIES TO AVOID VECTOR-
CN                       RECURSION IN DIF3D 7.0 AND LATER VERSIONS.    -
C                                                                      -
CN                       THE NODAL ORDERING IN DIF3D 7.0 AND LATER     -
CN                       VERSIONS HAS ACTIVE NODES ORDERED BY COLOR,   -
CN                       FOLLOWED BY INACTIVE NODES.                   -
C----------------------------------------------------------------------
C----------------------------------------------------------------------
CR            REGULAR FLUX MOMENTS    (3D RECORD)                      -
C                                                                      -
CL    ((FLUX(I,J),I=1,NMOM),J=1,NINTXY)------SEE STRUCTURE BELOW-----  -
C                                                                      -
CW    NMOM*NINTXY*MULT = NUMBER OF WORDS                               -
C                                                                      -
C     DO 1 K=1,NINTK                                                   -
C   1 READ(N)    *LIST AS ABOVE*                                       -
C                                                                      -
CD    FLUX(I,J)          REGULAR FLUX MOMENTS BY NODE FOR THE PRESENT  -
CD                       GROUP                                         -
C                                                                      -
C----------------------------------------------------------------------
C----------------------------------------------------------------------
CR            REGULAR XY-DIRECTED PARTIAL CURRENTS    (4D RECORD)      -
C                                                                      -
CD                                                                     -
CD                                                                     -
CL    ((PCURRH(I,M),I=1,NPCXY),M=1,NSCOEF) ----SEE STRUCTURE BELOW---- -
C                                                                      -
CW    NPCXY*NSCOEF*MULT = NUMBER OF WORDS                              -
C                                                                      -
C     DO 1 K=1,NINTK                                                   -
C   1 READ(N)    *LIST AS ABOVE*                                       -
C                                                                      -
CD    PCURRH(I,M)        OUTGOING XY-DIRECTED PARTIAL CURRENTS (M=1) AND-
CD                       HALF-ANGLE INTEGRATED FLUXES (M=2) ACROSS ALL -
CD                       XY-PLANE SURFACES FOR THE PRESENT GROUP       -
CD                                                                     -
CD                                                                     -
C                                                                      -
CN    ELEMENTS I=1,NSURF*NINTXY OF EACH VECTOR PCURRH(.,M) MAP TO      -
CN    SURFACE S OF NODE N WHERE  S = MOD(I-1,NSURF)+1  AND             -
CN    N = (I-1)/NSURF + 1                                              -
CN                                                                     -
CN    THE REMAINING ELEMENTS (PCURRH(I,M),I=NSURF*NINTXY+1,NPCXY),     -
CN    IF ANY, CORRESPOND TO INCOMING PARTIAL CURRENTS (M=1) OR INCOMING-
CN    HALF-ANGLE INTEGRATED FLUXES (M=2) FOR NODE SURFACES ON THE OUTER-
CN    (POSSIBLY IRREGULAR) XY-PLANE BOUNDARY.                          -
CN                                                                     -
CN    THE FOLLOWING ORIENTATION IS USED TO DENOTE                     -
CN    SURFACES J=1,...,NSURF AND NEIGHBORING NODES J=1,...,NSURF:      -
CN                                                                     -
CN           *                                        Y               -
CN      J=3 *   * J=2                                  ^               -
CN       *       *                          J=2        |               -
CN      *         *                       ******       |               -
CN      *         *                       *    *       |               -
CN  J=4 *         * J=1               J=3 *    * J=1   +----> X         -
CN      *         *                       *    *                       -
CN       *       *                        ******                       -
CN      J=5 *   * J=6                        J=4                        -
CN           *                                                         -
CN                                                                     -
CN     HEXAGONAL NODES                  CARTESIAN NODES                -
CN        NSURF = 6                        NSURF = 4                   -
C                                                                      -
C----------------------------------------------------------------------
```

```
C------------------------------------------------------------------------
CR          REGULAR  Z-DIRECTED PARTIAL CURRENTS   (5D RECORD)      -
C                                                                   -
CL     (((PCURRZ(I,M,J),I=1,NINTXY),M=1,NSCOEF),J=1,2)             -
CL                              ------SEE STRUCTURE BELOW--------
C                                                                   -
CW     NINTXY*NSCOEF*2*MULT = NUMBER OF WORDS                       -
C                                                                   -
C      DO 1 K=1,NINTK1                                              -
C    1 READ(N)   *LIST AS ABOVE*                                   -
C                                                                   -
CC          WITH NINTK1 = NINTK + 1                                -
C                                                                   -
CD     PCURRZ(I,M,J)     REGULAR Z-DIRECTED PARTIAL CURRENTS (M=1) AND  -
CD                       HALF-ANGLE INTEGRATED FLUXES (M=2) IN    -
CD                       PLUS- (J=1) AND MINUS- (J=2) Z DIRECTIONS -
CD                       ACROSS ALL AXIAL BOUNDARIES FOR THE PRESENT  -
CD                       GROUP                                    -
C                                                                   -
CN                       E.G. INCOMING PARTIAL CURRENTS FOR NODE I ON  -
CN                       AXIAL MESH INTERVAL K ARE PCURRZ(I,1,1) ON THE -
CN                       LOWER BOUNDARY (RECORD K) AND PCURRZ(I,1,2) ON -
CN                       THE UPPER AXIAL BOUNDARY (RECORD K+1).    -
C                                                                   -
C                                                                   -
C------------------------------------------------------------------------
CD     ============================================================ -
CD     NODAL METHOD - VARIANT 9.0 OPTION                           -
CD     ============================================================ -
C------------------------------------------------------------------------
CR          SPECIFICATIONS     (1D RECORD)                          -
C                                                                   -
CL     NDIM,NGROUP,NINTI,NINTJ,NINTK,ITER,EFFK,POWER,NSURF,        -
CL     NMOM,NINTXY,NPCXY,NSCOEF,ITRORD,IAPRX,ILEAK,IAPRXZ,ILEAKZ,  -
CL     IORDER,NPCBDY,NPCSYM,NPCSEC,IWNHFL,(IDUM,I=1,7)             -
C                                                                   -
CW     30 =NUMBER OF WORDS                                         -
C                                                                   -
CD     NDIM              NUMBER OF DIMENSIONS                      -
CD     NGROUP            NUMBER OF ENERGY GROUPS                   -
CD     NINTI             NUMBER OF FIRST DIMENSION FINE MESH INTERVALS  -
CD     NINTJ             NUMBER OF SECOND DIMENSION FINE MESH INTERVALS -
CD     NINTK             NUMBER OF THIRD DIMENSION FINE MESH INTERVALS. -
CD                       NINTK.EQ.1 IF NDIM.LE.2                   -
CD     ITER              OUTER ITERATION NUMBER AT WHICH FLUX WAS  -
CD                       WRITTEN                                   -
CD     EFFK              EFFECTIVE MULTIPLICATION FACTOR           -
CD     POWER             POWER IN WATTS TO WHICH FLUX IS NORMALIZED -
CD     NSURF             NUMBER OF XY-PLANE SURFACES PER NODE.     -
CD     NMOM              NUMBER OF FLUX MOMENTS IN NODAL APPROXIMATION  -
CD     NINTXY            NUMBER OF MESH CELLS (NODES) ON XY-PLANE  -
CD     NPCXY             NUMBER OF XY-DIRECTED PARTIAL CURRENTS ON -
CD                       XY-PLANE                                  -
CD     NSCOEF            NUMBER OF PARTIAL CURRENT MOMENTS PER NODE -
CD                       SURFACE                                   -
CD     ITRORD            ORDER OF THE POLYNOMIAL APPROXIMATION OF THE  -
CD                       SOURCE WITHIN THE NODE                    -
CD     IAPRX             ORDER OF THE POLYNOMIAL APPROXIMATION OF THE  -
CD                       FLUXES WITHIN THE NODE                    -
CD     ILEAK             ORDER OF THE POLYNOMIAL APPROXIMATION OF THE  -
CD                       LEAKAGES ON THE SURFACES OF THE NODES     -
CD     IAPRXZ            ORDER OF THE PN EXPANSION OF THE FLUX      -
CD     ILEAKZ            ORDER OF THE PN EXPANSION OF THE LEAKAGE   -
CD     IORDER            DIF3D VERSION                             -
CD                       =0, VERSION 8.0 OR PREVIOUS ONES          -
CD                       =2, VERSION 9.0                           -
CD     NPCBDY            NUMBER OF OUTGOING PARTIAL CURRENTS ON OUTER  -
CD                       XY-PLANE BOUNDARY.                        -
CD     NPCSYM            NUMBER OF OUTGOING PARTIAL CURRENTS ON     -
CD                       SYMMETRIC XY-PLANE BOUNDARY. HEXAGONAL     -
CD                       GEOMETRY ONLY.                            -
CD     NPCSEC            NUMBER OF OUTGOING PARTIAL CURRENTS ON     -
```

```
CD                              SECTOR XY-PLANE BOUNDARY. HEXAGONAL GEOMETRY   -
CD                              ONLY.                                         -
CD      IWNHFL                  NHFLUX CONTENT                                -
CD                              =0, BOTH FLUXES AND PARTIAL CUURENTS ARE       -
CD                                  PRESENT IN THE FILE                        -
CD                              =1, ONLY FLUXES ARE PRESENT                    -
CD                              =2, ONLY PARTIAL CURRENTS ARE PRESENT          -
CD      IDUM                    RESERVED FOR FUTURE USE                        -
C                                                                             -
C----------------------------------------------------------------------------
C----------------------------------------------------------------------------
CR          INTEGER POINTERS    (2D RECORD)                                   -
C                                                                             -
CC          PRESENT IF NSURF.GT.1                                             -
C                                                                             -
CL    (IPCPNT(I,J),I=1,NSURF),J=1,NINTXY),(IPCBDY(I),I=1,NPCBDY),             -
CL    (ITRMAP(I),I=1,NINTXY),(IPCSYM(I),I=1,NPCSTO),                          -
CL    (IPCSCP(I),I=1,NPCSTO)                                                  -
C                                                                             -
CW    NSURF*NINTXY + NPCBDY + NINTXY + 2*NPCSTO =NUMBER OF WORDS              -
C                                                                             -
CD      IPCPNT(I,J)       POINTERS TO INCOMING XY-PLANE PARTIAL CURRENTS.-
CD      IPCBDY(I)         POINTERS TO OUTGOING PARTIAL CURRENTS ON OUTER -
CD                        XY-PLANE BOUNDARY.                              -
CD      ITRMAP(I)         TRANSFORMATION MAP BETWEEN NODAL AND GEODST     -
CD                        MESH CELL ORDERINGS.                            -
CD      IPCSYM(I)         POINTERS TO OUTGOING PARTIAL CURRENTS ON        -
CD                        SYMMETRIC AND SECTOR XY-PLANE BOUNDARY.         -
CD                        HEXAGONAL GEOMETRY ONLY.                        -
CD      IPCSTO(I)         POINTERS TO INGOING PARTIAL CURRENTS ON         -
CD                        SYMMETRIC AND SECTOR XY-PLANE BOUNDARY.         -
CD                        HEXAGONAL GEOMETRY ONLY.                        -
CD      NPCSTO            = NPCSYM + NPCSEC                               -
CD      NPCXY             = NSURF*NINTXY + NPCBDY + NPCSTO                -
C                                                                             -
C                                                                             -
C----------------------------------------------------------------------------
C----------------------------------------------------------------------------
CR          REGULAR FLUX MOMENTS    (3D RECORD)                              -
C                                                                             -
CL    ((FLUX(I,J),I=1,NMOM),J=1,NINTXY)------SEE STRUCTURE BELOW-----  -
C                                                                             -
CW    NMOM*NINTXY*MULT = NUMBER OF WORDS                                      -
C                                                                             -
C     DO 1 K=1,NINTK                                                          -
C   1 READ(N)   *LIST AS ABOVE*                                              -
C                                                                             -
CD    FLUX(I,J)         REGULAR FLUX MOMENTS BY NODE FOR THE PRESENT    -
CD                      GROUP                                            -
C                                                                             -
C----------------------------------------------------------------------------
C----------------------------------------------------------------------------
CR          REGULAR XY-DIRECTED PARTIAL CURRENTS    (4D RECORD)             -
C                                                                             -
CD                                                                           -
CL    ((PCURRH(M,I),M=1,NSCOEF),I=1,NPCXY) ----SEE STRUCTURE BELOW---- -
C                                                                             -
CW    NPCXY*NSCOEF*MULT = NUMBER OF WORDS                                     -
C                                                                             -
C     DO 1 K=1,NINTK                                                          -
C   1 READ(N)   *LIST AS ABOVE*                                              -
C                                                                             -
CD    PCURRH(M,I)        OUTGOING XY-DIRECTED PARTIAL CURRENTS         -
CD                       ACROSS ALL XY-PLANE SURFACES FOR THE          -
CD                       THE PRESENT GROUP                             -
CD    ============================================================== -
C                                                                             -
CN    ELEMENTS I=1,NSURF*NINTXY OF EACH VECTOR PCURRH(M,.) MAP TO      -
CN    SURFACE S OF NODE N WHERE   S = MOD(I-1,NSURF)+1   AND           -
CN    N = (I-1)/NSURF + 1. M INDEX OF PARTIAL CURRENT MOMENT.          -
CN                                                                             -
CN    THE REMAINING ELEMENTS (PCURRH(M,I),I=NSURF*NINTXY+1,NPCXY),     -
```

```
CN     IF ANY, CORRESPOND TO INCOMING PARTIAL CURRENTS ON THE OUTER    -
CN     (POSSIBLY IRREGULAR) XY-PLANE BOUNDARY.                         -
CN                                                                     -
CN     THE FOLLOWING ORIENTATION IS USED TO DENOTE                     -
CN     SURFACES J=1,...,NSURF AND NEIGHBORING NODES J=1,...,NSURF:     -
CN                                                                     -
CN              *                                        Y            -
CN        J=3  *   * J=2                                 ^            -
CN           *       *                        J=2        |            -
CN          *         *                     ******       |            -
CN         *           *                    *    *       |            -
CN    J=4 *             * J=1        J=3 *       * J=1   +----> X      -
CN         *           *                    *    *                    -
CN          *         *                     ******                    -
CN        J=5  *   * J=6                       J=4                     -
CN              *                                                     -
CN                                                                     -
CN      HEXAGONAL NODES                   CARTESIAN NODES              -
CN         NSURF = 6                        NSURF = 4                  -
C                                                                      -
C----------------------------------------------------------------------
C----------------------------------------------------------------------
CR           REGULAR  Z-DIRECTED PARTIAL CURRENTS   (5D RECORD)        -
C                                                                      -
CL    (((PCURRZ(M,I,J),M=1,NSCOEF),I=1,NINTXY),J=1,2)                  -
CL                                     ------SEE STRUCTURE BELOW--------
C                                                                      -
CW    NINTXY*NSCOEF*2*MULT = NUMBER OF WORDS                           -
C                                                                      -
C     DO 1 K=1,NINTK1                                                  -
C   1 READ(N)    *LIST AS ABOVE*                                       -
C                                                                      -
CC         WITH NINTK1 = NINTK + 1                                     -
C                                                                      -
CD    PCURRZ(M,I,J)     Z-DIRECTED PARTIAL CURRENTS IN                 -
CD                      PLUS- (J=1) AND MINUS- (J=2) Z DIRECTIONS      -
CD                      ACROSS ALL AXIAL BOUNDARIES FOR THE PRESENT    -
CD                      GROUP                                          -
C                                                                      -
CN                      E.G. INCOMING PARTIAL CURRENTS FOR NODE I ON   -
CN                      AXIAL MESH INTERVAL K ARE PCURRZ(1,I,1) ON THE -
CN                      LOWER BOUNDARY (RECORD K) AND PCURRZ(1,I,2) ON -
CN                      THE UPPER AXIAL BOUNDARY (RECORD K+1).         -
C----------------------------------------------------------------------
CEOF
```

```
C*********************************************************************
C                    Latest version 10/31/00                        -
C                    Current version 1.3 extracted 01/08/21          -
C                                                                    -
CF          DIF3D                                                    -
CE          ONE-, TWO-, AND THREE-DIMENSIONAL DIFFUSION THEORY       -
CE          MODULE DEPENDENT BINARY INPUT                            -
C                                                                    -
CN          THIS FILE DESCRIPTION IS FOR DIF3D/VARIANT 9.0           -
C                                                                    -
C*********************************************************************
C--------------------------------------------------------------------
CR          FILE IDENTIFICATION                                      -
C                                                                    -
CL     HNAME,(HUSE(I),I=1,2),IVERS                                   -
C                                                                    -
CW     1+3*MULT=NUMBER OF WORDS                                      -
C                                                                    -
CD     HNAME               HOLLERITH FILE NAME - DIF3D - (A6)        -
CD     HUSE(I)             HOLLERITH USER IDENTIFICATION (A6)        -
CD     IVERS               FILE VERSION NUMBER                       -
CD     MULT                DOUBLE PRECISION PARAMETER                -
CD                              1- A6 WORD IS SINGLE WORD            -
CD                              2- A6 WORD IS DOUBLE PRECISION WORD  -
C                                                                    -
C--------------------------------------------------------------------
C--------------------------------------------------------------------
CR          PROBLEM TITLE, STORAGE AND DUMP SPECIFICATIONS (1D RECORD) -
C                                                                    -
CL     (TITLE(I),I=1,11),MAXSIZ,MAXBLK,IPRINT                        -
C                                                                    -
CW     3+11*MULT=NUMBER OF WORDS                                     -
C                                                                    -
CD     TITLE               ANY ALPHANUMERIC CHARACTERS               -
CD     MAXSIZ              POINTR CONTAINER ARRAY SIZE IN FAST CORE   -
CD                         MEMORY (FCM) IN REAL*8 WORDS              -
CD     MAXBLK              POINTR CONTAINER ARRAY SIZE IN EXTENDED CORE -
CD                         MEMORY (ECM) IN REAL*8 WORDS              -
CD     IPRINT              POINTER DEBUGGING EDIT                     -
CD                         0...NO DEBUGGING PRINTOUT                 -
CD                         1...DEBUGGING DUMP PRINTOUT               -
CD                         2...DEBUGGING TRACE PRINTOUT              -
CD                         3...BOTH DUMP AND TRACE PRINTOUT          -
C                                                                    -
C--------------------------------------------------------------------
C--------------------------------------------------------------------
CR          PROBLEM INTEGER CONTROL PARAMETERS (2D RECORD)           -
C                                                                    -
CL     IPROBT,ISOLNT,IXTRAP,MINBSZ,NOUTMX,IRSTRT,LIMTIM,NUPMAX,IOSAVE, -
CL     1IOMEG,INRMAX,NUMORP,IRETRN,(IEDF(I),I=1,10),NOUTBQ,I0FLUX,   -
CL     2NOEDIT,NOD3ED,ISRHED,NSN,NSWMAX,IAPRX,IAPRXZ,NFMCMX,NXYSWP,NZSWP,-
CL     3ISYMF,NCMRZS,ISEXTR,NPNO,NXTR,IOMEG,IFULL,NVFLAG,ISIMPL,IWNHFL, -
CL     4IPERT,IHARM                                                  -
C                                                                    -
CW     47=NUMBER OF WORDS                                            -
C                                                                    -
CD     IPROBT              PROBLEM TYPE                              -
CD                         0...K-EFFECTIVE PROBLEM                   -
CD                         1...FIXED SOURCE PROBLEM                  -
CD     ISOLNT              SOLUTION TYPE                             -
CD                         0...REAL SOLUTION                        -
CD                         1...ADJOINT SOLUTION                     -
CD                         2...BOTH REAL AND ADJOINT SOLUTION       -
CD     IXTRAP              CHEBYSHEV ACCELERATION OF OUTER ITERATIONS -
CD                         0...YES, ACCELERATE THE OUTER ITERATIONS -
CD                         1...NO ACCELERATION                      -
CD     MINBSZ              MINIMUM PLANE-BLOCK (RECORD) SIZE IN REAL*8 -
CD                         WORDS FOR I/O TRANSFERS IN THE CONCURRENT -
CD                         ITERATION STRATEGY                       -
CD     NOUTMX              OUTER ITERATION CONTROL                   -
CD                         -3...BYPASS DIF3D MODULE.                 -
CD                         -2...PERFORM NEUTRONICS EDITS ONLY        -
```

```
CD                         -1...PERFORM NEUTRONICS EDITS AND CALCULATE    -
CD                            OPTIMUM OVERRELAXATION FACTORS ONLY          -
CD                         .GE.0...MAXIMUM NUMBER OF OUTER ITERATIONS      -
CD      IRSTRT            RESTART FLAG                                     -
CD                         0...THIS IS NOT A RESTART                       -
CD                         1...THIS IS A RESTART                           -
CD      LIMTIM           JOB TIME LIMIT, MAXIMUM (CP AND PP (OR WAIT))     -
CD                       PROCESSOR SECONDS                                 -
CD      NUPMAX           NUMBER OF UPSCATTER ITERATIONS                    -
CD                       PER OUTER ITERATION                               -
CD      IOSAVE           CONCURRENT ITERATION EFFICIENCY OPTION            -
CD                         0...PERFORM THE ESTIMATED NO. OF INNER          -
CD                            ITERATIONS FOR EACH GROUP                    -
CD                         1...AVOID THE LAST PASS OF INNER ITERATIONS     -
CD                            IN THOSE GROUPS FOR WHICH THE NUMBER OF      -
CD                            INNER ITERATIONS IN THE LAST PASS ARE LESS -
CD                            THAN A CODE DEPENDENT THRESHOLD              -
CD      IOMEG            OPTIMUM OVERRELAXATION FACTOR ESTIMATION          -
CD                       ACCELERATION OPTION.                              -
CD                         0...NO ACCELERATION.                            -
CD                         1...ASYMPTOTIC EXTRAPOLATION OF ITERATIONS IN   -
CD                            THE OPTIMUM OVERRELAXATION FACTOR            -
CD                            CALCULATION.                                 -
CD      INRMAX           MAXIMUM NUMBER OF ITERATIONS PERMITTED DURING     -
CD                       THE OPTIMUM OVERRELAXATION FACTOR ESTIMATION      -
CD                       PROCESS FOR EACH INNER (WITHIN GROUP)             -
CD                       ITERATION MATRIX.                                 -
CD      NUMORP           NUMBER OF OPTIMUM OVERRELAXATION FACTORS          -
CD      IRETRN           FLAG INDICATING CAUSE OF OUTER ITERATION          -
CD                       TERMINATION                                       -
CD                         0...INITIAL VALUE, PRIOR TO OUTER ITERATIONS    -
CD                         1...OUTER ITERATIONS CONVERGED                  -
CD                         2...MAXIMUM NUMBER OF OUTER ITERATIONS          -
CD                            PERFORMED                                    -
CD                         3...TIME LIMIT                                  -
CD      IEDF(1)          PROBLEM DESCRIPTION EDIT (IN ADDITION TO USER     -
CD                       INPUT SPECIFICATIONS WHICH ARE ALWAYS EDITED      -
CD                         0...NO EDITS                                    -
CD                         1...PRINT EDITS                                 -
CD                         2...WRITE EDITS TO AUXILIARY OUTPUT FILE        -
CD                         3...WRITE EDITS TO BOTH PRINT AND AUXILIARY     -
CD                            OUTPUT FILE                                  -
CD      IEDF(2)          GEOMETRY (REGION TO MESH INTERVAL) MAP EDIT       -
CD                         0...NO EDITS                                    -
CD                         1...PRINT EDITS                                 -
CD                         2...WRITE EDITS TO AUXILIARY OUTPUT FILE        -
CD                         3...WRITE EDITS TO BOTH PRINT AND AUXILIARY     -
CD                            OUTPUT FILE                                  -
CD      IEDF(3)          GEOMETRY (ZONE TO MESH INTERVAL) MAP EDIT         -
CD                         0...NO EDITS                                    -
CD                         1...PRINT EDITS                                 -
CD                         2...WRITE EDITS TO AUXILIARY OUTPUT FILE        -
CD                         3...WRITE EDITS TO BOTH PRINT AND AUXILIARY     -
CD                            OUTPUT FILE                                  -
CD      IEDF(4)          MACROSCOPIC CROSS SECTION EDIT                    -
CD                       ENTER TWO DIGIT NUMBER SP WHERE                   -
CD                                                                         -
CD                       S CONTROLS THE SCATTERING CROSS SECTIONS EDIT     -
CD                       P CONTROLS THE PRINCIPAL CROSS SECTIONS EDIT      -
CD                                                                         -
CD                       THE INTEGERS S AND P SHOULD BE ASSIGNED ONE OF    -
CD                       THE FOLLOWING VALUES (LEADING ZEROES ARE          -
CD                       IRRELEVANT)                                       -
CD                         0...NO EDITS                                    -
CD                         1...PRINT EDITS                                 -
CD                         2...WRITE EDITS TO AUXILIARY OUTPUT FILE        -
CD                         3...WRITE EDITS TO BOTH PRINT AND AUXILIARY     -
CD                            OUTPUT FILE                                  -
CD      IEDF(5)          BALANCE EDITS                                     -
CD                       ENTER 3 DIGIT NUMBER GBR WHERE                    -
CD                                                                         -
CD                       G CONTROLS GROUP BALANCE EDITS INTEGRATED OVER    -
```

137

```
CD                               THE REACTOR                         -
CD                               B CONTROLS REGION BALANCE EDIT BY GROUP    -
CD                               R CONTROLS REGION BALANCE EDIT TOTALS      -
CD                                 (INCLUDING NET PRODUCTION AND ENERGY MEDIANS)-
CD                                                                     -
CD                               THE INTEGERS G, B, AND R SHOULD BE ASSIGNED    -
CD                               ONE OF THE FOLLOWING VALUES (LEADING ZEROES    -
CD                               ARE IRRELEVANT)                       -
CD                               0...NO EDITS                          -
CD                               1...PRINT EDITS                       -
CD                               2...WRITE EDITS TO AUXILIARY OUTPUT FILE    -
CD                               3...WRITE EDITS TO BOTH PRINT AND AUXILIARY    -
CD                                   OUTPUT FILES                      -
CD     IEDF(6)             POWER EDITS                           -
CD                               ENTER 2 DIGIT NUMBER RM WHERE         -
CD                                                                     -
CD                               R CONTROLS REGION POWER AND AVERAGE POWER    -
CD                                 EDITS                               -
CD                               M CONTROLS POWER DENSITY BY MESH INTERVAL    -
CD                                 EDIT (PWDINT)                       -
CD                                                                     -
CD                               THE INTEGERS R AND M SHOULD BE ASSIGNED ONE OF -
CD                               THE FOLLOWING VALUES (LEADING ZEROES ARE    -
CD                               IRRELEVANT)                           -
CD                               0...NO EDITS                          -
CD                               1...PRINT EDITS                       -
CD                               2...WRITE EDITS TO AUXILIARY OUTPUT FILE    -
CD                               3...WRITE EDITS TO BOTH PRINT AND AUXILIARY    -
CD                                   OUTPUT FILE                       -
CD     IEDF(7)             TOTAL FLUX EDITS                      -
CD                               ENTER 3 DIGIT INTEGER RMB WHERE       -
CD                                                                     -
CD                               R CONTROLS TOTAL FLUX EDIT BY REGION AND GROUP -
CD                                 INCLUDING GROUP AND REGION TOTALS   -
CD                               M CONTROLS TOTAL FLUX EDIT BY MESH INTERVAL    -
CD                                 INTEGRATED OVER GROUP               -
CD                               B CONTROLS TOTAL FLUX EDIT BY MESH INTERVAL    -
CD                                 AND GROUP (RTFLUX OR ATFLUX)        -
CD                                                                     -
CD                               THE INTEGERS R, M, AND B SHOULD BE ASSIGNED    -
CD                               ONE OF THE FOLLOWING VALUES (LEADING ZEROES    -
CD                               ARE IRRELEVANT)                       -
CD                               0...NO EDITS                          -
CD                               1...PRINT EDITS                       -
CD                               2...WRITE EDITS TO AUXILIARY OUTPUT FILE    -
CD                               3...WRITE EDITS TO BOTH PRINT AND AUXILIARY    -
CD                                   OUTPUT FILE                       -
CD     IEDF(8)             ZONE AVERAGED FLUX EDIT               -
CD                               0...NO EDITS                          -
CD                               1...PRINT EDITS                       -
CD                               2...WRITE EDITS TO AUXILIARY OUTPUT FILE    -
CD                               3...WRITE EDITS TO BOTH PRINT AND AUXILIARY    -
CD                                   OUTPUT FILE                       -
CD     IEDF(9)             REGION AVERAGED FLUX EDIT             -
CD                               0...NO EDITS                          -
CD                               1...PRINT EDITS                       -
CD                               2...WRITE EDITS TO AUXILIARY OUTPUT FILE    -
CD                               3...WRITE EDITS TO BOTH PRINT AND AUXILIARY    -
CD                                   OUTPUT FILE                       -
CD     IEDF(10)            INTERFACE FILES TO BE WRITTEN IN ADDITION TO    -
CD                               RTFLUX AND/OR ATFLUX                  -
CD                               A 4 DIGIT INTEGER FSRP WHERE          -
CD                                                                     -
CD                               F CONTROLS WRITING OF FAST FLUXES ON SFEDIT    -
CD                               S CONTROLS WRITING OF POWER-DENSITY ON SFEDIT  -
CD                               R CONTROLS WRITING OF RZFLUX          -
CD                               P CONTROLS WRITING OF PWDINT          -
CD                                                                     -
CD                               0...DO NOT WRITE THE INTERFACE FILE   -
CD                               1...WRITE THE INTERFACE FILE (SFEDIT WILL BE    -
CD                                   WRITTEN IN STANDARD MESH CELL ORDERING)    -
CD                               2...WRITE THE SFEDIT FILE IN REGION ORDER    -
```

138

```
CD                            (OPTION 2 IS PERTINENT TO SFEDIT ONLY)     -
CD         NOUTBQ        NUMBER OF OUTER (POWER) ITERATIONS BEFORE        -
CD                       ASYMPTOTIC EXTRAPOLATION OF NEAR CRITICAL        -
CD                       SOURCE PROBLEM.                                  -
CD         I0FLUX        FLAT FLUX GUESS SENTINEL.                        -
CD                       0...FLAT FLUX GUESS = 1.0                        -
CD                       1...FLAT FLUX GUESS = 0.0                        -
CD         NOEDIT        PRINT FILE MASTER CONTROL FLAG                   -
CD                       0...PRINT GENERAL RUN INFORMATION AND            -
CD                          REQUESTED EDITS                              -
CD                       1...SUPPRESS ALL OUTPUT EXCEPT DIAGNOSTIC        -
CD                          EDITS AND THE ITERATION HISTORY              -
CD                       2...SUPPRESS ALL OUTPUT EXCEPT DIAGNOSTIC EDITS-
CD         NOD3ED        D3EDIT FILE MASTER CONTROL FLAG                  -
CD                       0...WRITE REQUESTED EDITS ON D3EDIT FILE         -
CD                       1...DO NOT WRITE D3EDIT FILE                     -
CD         ISRHED        MASTER NEUTRONICS EDIT SENTINEL DURING           -
CD                       CRITICALITY SEARCHES ONLY.                       -
CD                      -1...SUPPRESS ALL DIF3D EDITS EXCEPT ITERATION    -
CD                          HISTORY AND ERROR DIAGNOSTICS.               -
CD                       0...EDIT INPUT DATA ON 1ST SEARCH PASS, OUTPUT -
CD                          FLUX INTEGRALS UPON CONVERGENCE OR UPON      -
CD                          ACHIEVING THE MAXIMUM SEARCH PASS LIMIT.     -
CD                       N...ALSO EDIT SPECIFIED DIF3D EDITS EVERY N-TH -
CD                          SEARCH PASS.                                 -
CD         NSN           SN ORDER (TRANSPORT OPTION)                      -
CD         NSWMAX        MAXIMUM ALLOWED NUMBER OF LINE SWEEPS PER LINE -
CD                       PER INNER ITERATION (TRANSPORT OPTION).          -
CD         NAPRX         ORDER OF NODAL APPROXIMATION IN XY-PLANE         -
CD                       READ FROM A.DIF3D CARD TYPE 10 (NODAL OPTION)    -
CD                       **OR** NODAL SPATIAL APPROXIMATION READ FROM     -
CD                       CARD TYPE 12 (VARIANT OPTION)                    -
CD         NAPRXZ        ORDER OF NODAL APPROXIMATION IN Z-DIRECTION      -
CD                       READ FROM A.DIF3D CARD TYPE 10 (NODAL OPTION)    -
CD                       **OR** NODAL ANGULAR APPROXIMATION READ FROM     -
CD                       CARD TYPE 12 (VARIANT OPTION)                    -
CD         NFMCMX        COARSE-MESH REBALANCE ACCELERATION CONTROL       -
CD                       (NODAL OPTIONS)                                  -
CD                      -1...NO COARSE-MESH REBALANCE ACCELERATION        -
CD                      .GT.0...NUMBER OF FINE MESH PER REBALANCE MESH IN -
CD                          X- AND Y-DIRECTIONS                          -
CD         NXYSWP        NUMBER OF XY-PLANE PARTIAL CURRENT SWEEPS PER    -
CD                       PER AXIAL SWEEP PER OUTER ITERATION (NODAL       -
CD                       AND VARIANT OPTIONS)                             -
CD         NZSWP         NUMBER OF AXIAL PARTIAL CURRENT SWEEPS PER       -
CD                       GROUP PER OUTER ITERATION (NODAL OPTIONS)        -
CD         ISYMF         HALF-DOMAIN SYMMETRY FLAG (NODAL OPTIONS)        -
CD                      -1...DO NOT USE 30 DEGREE (HEXAGONAL GEOMETRY) -
CD                          OR 45 DEGREE (CARTESIAN GEOMETRY) SYMMETRY-
CD                          EVEN IF SUCH SYMMETRY EXISTS                 -
CD                       0...USE 30 DEGREE (HEXAGONAL GEOMETRY) OR        -
CD                          45 DEGREE (CARTESIAN GEOMETRY) SYMMETRY      -
CD                          IF SUCH SYMMETRY EXISTS                      -
CD         NCMRZS        NUMBER OF AXIAL COARSE-MESH REBALANCE            -
CD                       NUMBER PAIRS (NODAL OPTIONS)                     -
CD         ISEXTR        SENTINEL FOR ASYMPTOTIC EXTRAPOLATION OF         -
CD                       FISSION SOURCE AND PARTIAL CURRENTS (NODAL OPS)-
CD         NPNO          ANISOTROPIC SCATTERING APPROXIMATION (VARIANT).-
CD         NXTR          EXTENDED TRANSPORT APPROXIMATION ON TOTAL        -
CD                       CROSS SECTION.(VARIANT)                          -
CD         IOMEG         OMEGA TRANSFORMATION ACCELERATION OPTION.        -
CD         IFULL         RADIAL INNER ITERATION ALGORITHM.(VARIANT)       -
CD         NVFLAG        0...VARIANT OPTION NOT REQUESTED                 -
CD                       1...VARIANT OPTION REQUESTED                     -
CD         ISIMPL        0...SIMPLE SPHERICAL HARMONICS NOT REQUESTED     -
CD                       1...SIMPLE SPHERICAL HARMONICS REQUESTED (VAR) -
CD         IWNHFL        NHFLUX WRITING (FLUX AND/OR PARTIAL CURRENTS)    -
C                        OPTION. (VAR)                                    -
CD         IPERT         PERTURBATION OPTION FOR SOURCE FULL EXPANSION. -
C                        (VAR)                                           -
CD         IHARM         HARMONIC NUMBER TO BE CALCULATED. (VAR)          -
C                                                                         -
```

```
CN      THE CODE DEPENDENT INTERFACE FILE SFEDIT CONTAINS SURFACE- AND   -
CN      CELL-AVERAGED POWER DENSITY AND/OR FAST FLUX DATA.  IT MAY BE     -
CN      WRITTEN IN STANDARD FINE MESH CELL ORDER OR IN REGION ORDER.      -
C                                                                        -
C------------------------------------------------------------------------
C------------------------------------------------------------------------
CR              CONVERGENCE CRITERIA AND OTHER FLOATING POINT DATA        -
CR          (3D RECORD)                                                   -
C                                                                        -
CL      EPS1,EPS2,EPS3,EFFK,FISMIN,PSINRM,POWIN,SIGBAR,EFFKQ,             -
CL      1EPSWP,(DUM(I),I=1,20)                                            -
C                                                                        -
CW      30*MULT=NUMBER OF WORDS                                           -
C                                                                        -
CD      EPS1                EIGENVALUE CONVERGENCE CRITERION FOR STEADY   -
CD                          STATE CALCULATION                            -
CD      EPS2                POINTWISE FISSION SOURCE CONVERGENCE CRITERION -
CD                          FOR STEADY STATE SHAPE CALCULATION           -
CD      EPS3                AVERAGE FISSION SOURCE CONVERGENCE CRITERION   -
CD                          FOR STEADY STATE SHAPE CALCULATION           -
CD      EFFK                K-EFFECTIVE OF REACTOR                        -
CD      FISMIN              ANY POINTWISE FISSION SOURCE WILL BE NEGLECTED -
CD                          IN THE POINTWISE FISSION SOURCE CONVERGENCE   -
CD                          TEST IF IT IS LESS THAN THIS FACTOR TIMES     -
CD                          THE R.M.S. FISSION SOURCE                     -
CD      PSINRM              ERROR REDUCTION FACTOR TO BE ACHIEVED BY EACH  -
CD                          SERIES OF INNER ITERATIONS FOR EACH GROUP     -
CD                          DURING A SHAPE CALCULATION                    -
CD      POWIN               STEADY STATE REACTOR POWER (WATTS)            -
CD      SIGBAR              DOMINANCE RATIO                               -
CD      EFFKQ               EIGENVALUE OF THE HOMOGENEOUS PROBLEM         -
CD                          CORRESPONDING TO THE NEAR CRITICAL            -
CD                          SOURCE PROBLEM. (PERTINENT WHEN NOUTBQ.GT.0)  -
CD      EPSWP               LINE SWEEP CONVERGENCE CRITERION (TRANSPORT   -
CD                          OPTION)                                       -
CD      DUM(I)              RESERVED                                      -
C                                                                        -
C------------------------------------------------------------------------
C------------------------------------------------------------------------
CR          OPTIMUM OVERRELAXATION FACTORS (4D RECORD)                    -
C                                                                        -
CC          PRESENT IF NUMORP.GT.0                                        -
C                                                                        -
CL      (OMEGA(I),I=1,NUMORP)                                             -
C                                                                        -
CW      NUMORP*MULT=NUMBER OF WORDS                                       -
C                                                                        -
CD      OMEGA(I)            OPTIMUM OVERRELAXATION FACTOR FOR GROUP I      -
CD                          ON THIS FILE, OPTIMUM OVERRELAXATION FACTORS   -
CD                          ARE --ALWAYS-- ORDERED BY THE --REAL PROBLEM-- -
CD                          ORDERING                                      -
C                                                                        -
C------------------------------------------------------------------------
C------------------------------------------------------------------------
CR          AXIAL COARSE-MESH REBALANCE BOUNDARIES FOR NODAL              -
CR          OPTION (5D RECORD)                                            -
C                                                                        -
CC          PRESENT IF NCMRZS.GT.0                                        -
C                                                                        -
CL      (ZCMRC(I),I=1,NCMRZS),(NZINTS(I),I=1,NCMRZS)                      -
C                                                                        -
CW      NCMRZS*(MULT+1)=NUMBER OF WORDS                                   -
C                                                                        -
CD      ZCMRC(I)            UPPER Z-COORDINATE OF AXIAL COARSE-MESH        -
CD                          REBALANCE SPECIFICATION INTERVAL I.           -
CD      NZINTS(I)           NUMBER OF AXIAL COARSE MESH REBALANCE INTERVALS-
CD                          IN I-TH SPECIFICATION INTERVAL.               -
C                                                                        -
CN                  THERE ARE NZINTS(I) AXIAL COARSE-MESH REBALANCE       -
CN                  INTERVALS BETWEEN ZCMRC(I-1) AND ZCMRC(I), WHERE      -
CN                  WHERE ZCMRC(0) IS THE LOWER REACTOR BOUNDARY          -
CN                  IN THE Z-DIRECTION. THE ZCMRC(I) ARE ORDERED SUCH     -
```

```
CN                THAT ZCMRC(I+1).GT.ZCMRC(I).                        -
C                                                                    -
C--------------------------------------------------------------------
CEOF
```